an

Environmental Plan

for the

Ulm Planning District

Cascade County, Montana

Charity Fechter & Cole Waldo

Resources Development Internship Program
Western Interstate Commission for Higher Education

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AN ENVIRONMENTAL PLAN

for the

ULM PLANNING DISTRICT

of

CASCADE COUNTY, MONTANA

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September, 1976

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August 17, 1976

OPEN LETTER TO THE READERS

OF THE

ULM PLANNING DISTRICT ENVIRONMENTAL PLAN

This document is the first of two (2) sections which will, when finished, comprise the Comprehensive Land-use Plan for the Ulm Planning District. This plan should be completed by August 31, 1978.

The Cascade County Planning Board was formed by order of the Board of County Commissioners on January 22, 1974. At that time the Planning Board committed itself to an orderly and open process for developing a comprehensive land-use plan for Cascade County. Since that time the Planning Board has hired a professional staff to put together a land-use inventory and ancillary data to formulate a model from which a plan could be written.

The needs, wants, desires and opinions of the citizens living in the different parts of Cascade County will be incorporated in an on-going process by which the Citizen's Advisory Committees, formed throughout the county, will develop sets of goals and policies reflecting the community's viewpoints as to how the planning process should proceed and how the land around them should be used. In this way the people of Cascade County will have an opportunity to control their own future and life style.

The County Planning Department is charged with the task of implementing these goals and policies, by first writing the comprehensive plan and then developing controls and proposed ordinances. All plans, ordinances, and controls will then go through a public hearing process for final review by the citizens of the County.

This plan is designed to reflect the policies and goals developed by the Ulm Planning District Citizen's Advisory Committee whose long hours of dedication will provide valuable assistance to the planning staff. This plan therefore, belongs to the citizens of the Ulm Planning District.

Sincerely,

Marcia H. Staigmiller
Chairperson
Cascade County Planning Board

WGM/pb

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ABSTRACT

This report is the environmental plan for the Ulm Planning District. It is made up of four (4) basic elements: 1) Landscape Units, their soils, geology, topography, hydrology and biology, with suggested development and conservation policies for each landscape unit; 2) Critical Hazard Areas, defined, with suggested performance standards and policies for each hazard type; 3) Public Open Space Program, with some methods of implementation; 4) Priority Resource Areas, with suggested policies and actions to protect these resources. A glossary of terms that may be unfamiliar is also included. There are, as well, four (4) appendices: 1) Definition of Landscape Units; 2) Geologic Time Scale; 3) Endangered Species; 4) Alternative Energy.

INTRODUCTION

The comprehensive plan for Cascade County is being developed in two (2) parts: an environmental plan and a community plan for each of the eleven (11) planning districts. The environmental plan deals with the natural setting for the social and economic activities to be covered in the community plan. With the completion of each environmental plan residents within the various planning districts will be contacted, then a community plan will be developed by the Citizen's Advisory Committee in each district.

Each district's environmental plan is made up of four (4) basic elements: landscape units, critical hazard areas, open space program and priority resource areas. Each element performs a specific purpose in incorporating environmental data and policies into the comprehensive plan.

Landscape Units - The county has been broken into nine (9) landscape units, with each representing a particular combination of soils, geology, topography, hydrology and biology. The landscape units therefore provide a simplified framework for development and conservation policies and apply to the same landscape unit throughout the county.

Critical Hazard Areas - Areas of known soil instability, flooding, stream and river bank erosion as well as wind erosion are identified by text. In the interest of protecting life and property, performance standards and policies have been developed for each type of hazard.

Public Open Space Program - Open space designations in this plan are restricted to sites which can be publicly controlled and maintained and which can serve a function for recreation, scenic value, wildlife habitat, cultural or educational interest.

Priority Resource Areas - Those resources with economic value are identified and described. Policies and actions are set forth in the plan to protect forest (silvaculture), agriculture and mineral resources.

When combined, the elements of the environemtnal plan provide a foundation for social and economic policies in the community plan. There is established a systematic format for dealing with hazards, economic resources and open space needs, as well as developing relationships between soils, air, water and living organisms. The plan sets a framework for policies and performance standards but is flexible enough to accomodate changes in policies - should such occur. The policies provide specific guidelines for establishing ordinances and making decisions.

DESCRIPTION AND HISTORY

Cascade County is located in north-central Montana east of the continental divide. Topography of the area varies from very mountainous in its southern third to rolling plains in its northern portion. Elevations range from peaks over 8000 feet to river bottoms near 2700 feet. The county is drained by four major rivers and creeks which include the Missouri River, Sun River, Smith River, and Belt Creek. The climate has many "Continental" characteristics with an important exception being the so called "chinook" which is an occasional warm winter wind. Warm summers and cold arctic winters are normal in the area. Rainfall generally occurs in the spring and summer months.

The first penetration by white men of the area within the present boundaries of Cascade County was made by the Lewis and Clark Expedition in June, 1805. The area was soon named for the many falls and cascades which characterize the area.

Organization of the county took place on September 19, 1887, when Cascade County was formed from parts of adjacent Chouteau, Lewis and Clark, and Meagher Counties. 1887 was also the year when railroads first arrived and connected the area to other parts of the nation. Spur lines were constructed to many local mining areas making Great Falls the transportation hub for much of north-central Montana.

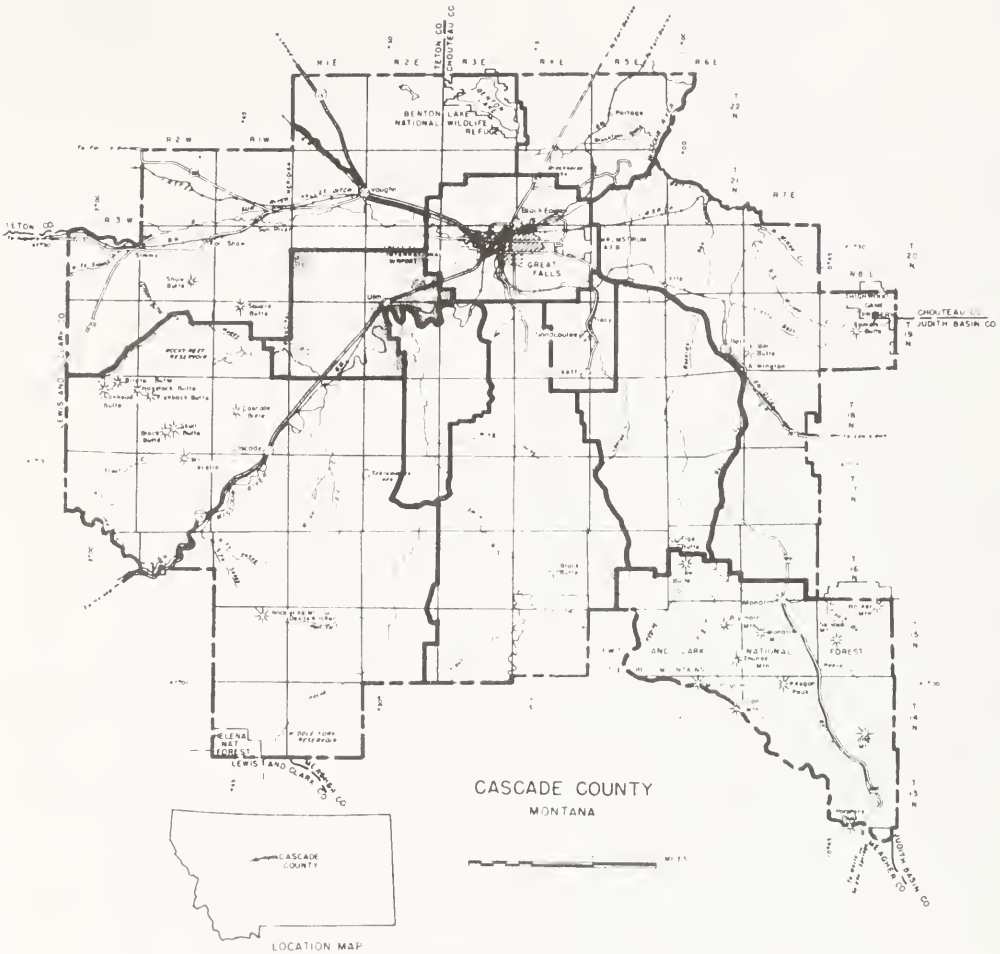
Cascade County is also the site of Montana's first hydroelectric plant: Black Eagle Plant. It was built in 1890 in the canyon near Great Falls. Since that date a series of five (5) hydroelectric dams have been constructed on the Missouri River within the county.

Mining and agriculture have played a very important role in development of the area. Major mining operations took place in the southeastern part of the county but have since been discontinued. Smelting operations for copper and zinc have played an important part in the development of the Great Falls area.

Great Falls is a regional center for agricultural exchange and supply. Cattle and grain are the primary agricultural products and provide the economic base for the area.

Another important factor to development of the area was the addition of Malmstrom Air Force Base and its numerous projects. Light diversified manufacturing has also been important to growth of the area as well as increased services available to customers.

Population of Cascade County as of 1970 was 81,631. Approximately 87% is urban, 10% rural non-farm, and 3% rural farms. Distribution of the population closely follows the Missouri and Sun Rivers. Incorporated towns within the county include Great Falls, Cascade, Belt, and Neihart. Many unincorporated towns and villages also exist.



ULM PLANNING DISTRICT

SECTION I

LANDSCAPE UNITS

SECTION I - LANDSCAPE UNITS

The landscape unit section is the first of the four (4) basic elements comprising the environmental plan. This section provides the framework for setting forth environmental policies based on existing natural conditions. The landscape unit designations and the recommendations attached to each unit will be useful in establishing performance standards in the community plan.

Each landscape unit reflects a set of characteristics which constitutes a natural process. The soils, hydrology, biology, and landforms are interrelated as a functional, natural unit. Environmental policies are established to reflect the overall natural process of a landscape unit, as well as specific resource limitations.

Every parcel of land in the county is within a landscape unit. The landscape unis found in the Ulm Planning District are:

1. Rivers, reservoirs, lakes and streams
2. Alluvial lowlands
3. Sedimentary terraces or benches

Other landscape units within Cascade County are:

1. Sedimentary foothills
2. Sedimentary uplands
3. Igenous foothills
4. Igneous uplands
5. Metamorphic uplands
6. Buttes

The flexibility of the Environmental Plan allows the addition of other units, as warranted by specific conditions. Development policies attached to each landscape unit apply to all lands within the landscape unit. As a general rule, no piece of land will fall in more than one landscape unit. An individual landowner, however, may have land in two (2) or more units.

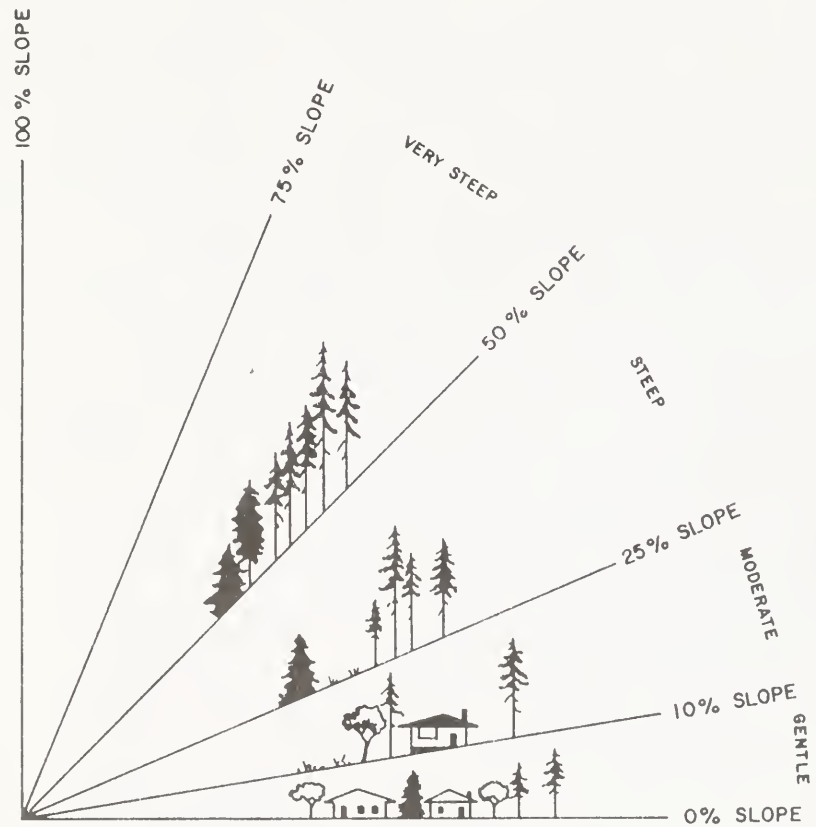
For each landscape unit, the following information is provided:

1. Definition of the landscape unit.
2. Extent and description of that landscape unit within the planning district.
3. The slope, geology, soils, vegetation, wildlife, and land-use characteristics.
4. Example area.
5. Suggested development policies for that landscape unit.
6. Recommended actions to implement the policies.

A map of the planning district showing the landscape units at a scale of one (1) inch equal to two (2) miles (1:126,720) accompanies this section. The map is as accurate as possible at this scale and there should be no question as to which landscape unit a particular parcel belongs. In cases where there is some question, an on-site inspection may be required to make a determination. Given the detailed descriptions provided in this section, the reader should have little difficulty placing a site in the appropriate landscape unit.

Appendix A defines all the landscape units found in Cascade County. Three (3) of the nine (9) landscape units are found in the Ulm Planning District.

DEGREES OF TOPOGRAPHIC SLOPE



RIVERS, RESERVOIRS, LAKES, STREAMS - LANDSCAPE UNIT

DEFINITION - Includes water bodies either flowing or standing all or most of the year. Lands immediately adjacent to water bodies which directly influence the physical, biological, and chemical properties of the water are also included in this landscape unit.

EXTENT AND DESCRIPTION - The Missouri River is a major feature of this landscape unit. It is the largest stream in the unit and has many meanders. There are also some oxbow lakes associated with the Missouri River. The Missouri in the Ulm District meanders from Section 35, Township 19 North, Range 1 East to Section 6, Township 19 North, Range 2 East. There are several islands in the Missouri River.

There are four (4) reservoirs in the Ulm Planning District, as well as several lakes. Principal creeks are Little Muddy and Dry Fork Creeks. Many of the streams are intermittent, as are several of the lakes. Agriculture and recreation are the important land uses.

VEGETATION - The natural vegetation is similar to that found in the alluvial lowlands which consists of: native cottonwoods; willow; brush, including chokecherry and serviceberry; native grasses and shrubs, such as slough grass, wild barley, sage, rushes and sedges. The rivers have a greater variety of marsh grasses and algae.

WILDLIFE - Fish and waterfowl are the most important wildlife of this landscape unit. Game fish, such as trout, pike, and catfish, can be found in all annual streams and many of the reservoirs and lakes. Waterfowl includes ducks, gulls, and occasional geese and swans. Blackbirds, magpies, and other birds are also found in this area.

GEOLOGIC HAZARDS - Flooding is the major hazard of this landscape unit. Water control by the dam systems on the Missouri River south of Cascade County has alleviated the problem to some extent, but high water flow or blockages of the river by ice jams can cause flooding of the lowlands.

CHARACTERISTICS -

GEOLOGY - The geologic formations of this landscape unit are primarily of the Quaternary Period (3 million years ago). The rivers flow on dune sand and glacial lake deposits which have gradually filled the valley bottom.

SOILS - Rivers, reservoirs, lakes and streams are found primarily on Straw-Libra-Nesda and Absher-Nobe association soils. Both soil types are discussed under the alluvial lowlands landscape unit.

SLOPE - Gentle, 0 - 2% riverbanks.

EXAMPLE AREA LOCATION - Confluence of Little Muddy and Dry Fork Creeks in a reservoir in Section 32, Township 19 North, Range 1 East, Montana Prime Meridian.

SUGGESTED POLICIES -

1. Since the rivers, reservoirs, lakes and streams are of the highest priority in terms of recreation, aesthetics, agriculture, and wildlife habitat, every effort should be made to preserve their present integrity.
2. Wildlife habitat should be protected from land use changes.
3. Rechanneling of streams should be discouraged.
4. Public access to all rivers and streams should be provided at regular intervals.
5. Areas designated for their unique and fragile or recreational potentials should be protected by whatever means are most feasible.
6. Vegetation buffer zones along streams should be managed primarily for water quality, stream protection, and wildlife habitat.
7. Efforts should be directed toward maintaining or improving water quality.

RECOMMENDED ACTIONS -

1. The county should coordinate all proposed actions affecting the Missouri River with Montana Department of Fish and Game and the U.S. Soil Conservation Service to prevent adverse effects on wildlife.
2. Agricultural lands would be given priority, but special efforts should be made to prevent erosion.
3. Establish minimum flows in streams and rivers to protect the wildlife, water quality, and recreational uses of this landscape unit.

ALLUVIAL LOWLANDS - LANDSCAPE UNIT

DEFINITION - The plains occupying the valley floors which are the result of deposition of material by water. The floodplain is the major conspicuous feature of this landscape unit.

EXTENT AND DESCRIPTION - The alluvial lowlands landscape unit in the Ulm District is closely associated with the Missouri River and Little Muddy Creek. The floodplains and flatlands of this landscape unit extend almost to Taft Hill northwest of Ulm, and follow the Missouri River south to the boundary of this district. The area on both sides of Little Muddy Creek, a tributary of the Missouri, is also in this landscape unit.

The alluvial lowlands rise from the river to the 3400 foot contour, a rise of less than 100 feet. Width of the lowlands varies from 1 to 4½ miles. There are several small lakes and reservoirs in close proximity to the streams and rivers in the area.

Ulm, an agriculturally oriented community of slightly more than 300, is located in the widest part of the alluvial lowlands of the Missouri River. Primary land use in the alluvial lowlands unit is agriculture.

VEGETATION - The largest percentage of vegetation in the alluvial lowlands is cultivated. Modification of the natural landscape for agricultural purposes has caused a scarcity of much of the natural vegetation. Natural vegetation includes: native cottonwoods; willow; brush, including chokecherry and serviceberry; native grasses and shrubs, such as slough grass, wild barley, sage, rushes, and sedges.

WILDLIFE - Excellent big game habitat is found in the alluvial lowlands. Mule deer and whitetail deer can be found year round while antelope use the area for their winter range. Game birds found in this landscape unit include pheasant, sharptail grouse, Hungarian partridge, and some ducks. Many other birds such as robins, blackbirds and sparrows may also be found. Small game animals such as otter, ground squirrels, rodents and many others also inhabit this landscape unit. Bald eagle and osprey sometimes use this area as a feeding ground.

GEOLOGIC HAZARDS - The major hazards of the alluvial lowlands are stream flooding, bank erosion, and dune sand formation. Flooding is the primary hazard at the lower elevations along the Missouri River and its tributaries. Development of Holter, Hauser and Canyon Ferry Dams has regulated flows along the Missouri River in recent years. Flooding on small drainages is evident when high rainfall and snow fall occurs, giving them the potential to be hazardous. Bank erosion is often a result of flooding and may be hazardous to nearby development. Dune sand formation often occurs in the alluvial lowlands and is usually caused by wind erosion. Sand can be detrimental to agricultural systems.

CHARACTERISTICS -

GEOLOGY - The alluvial lowlands are composed of sands, silt and clay eroded from the local landscape or deposited by glacial lakes. The area is relatively flat with many cut off stream meanders marking the former river bed. Gravel lenses, composed of subrounded, moderately well sorted material, are also found in the lowlands. The sediments are believed to be of the early Quaternary period (3 million years ago). The alluvial formations follow the river beds and the adjacent low flatlands or floodplain. These formations lie on the siltsone-shales of the Marias River formation. Dune sands have formed on much of the flatlands and are presently active. They are the result of wind erosion of the many sandstones found in the area.

SOILS - The majority of the soils in the alluvial lowlands are of the Absher-Nobe Association. This association is characterized by deep, very slowly permeable, saline-alkaline clays. The Absher soils usually occur on the slightly elevated areas between the barren spots of Nobe soils. The deep, well drained, alkaline soils have a loamy surface soil 2 inches to 4 inches thick over dense, very slowly permeable clay soils. The slow permeability of the Absher soils limits their suitabilitiy for septic tank filter fields.

Nobe soils are deep, barren to nearly barren, strongly alkaline clay soils. These moderately well drained, very slowly permeable soils have limited use as septic fank filter fields. The Absher-Nobe association is used primarily for grazing.

The Straw-Libra-Nesda association is found adjacent to the Missouri River. These soils are mainly deep, well drained, dark colored loams and sandy loams. Shallow, very gravelly soils occur in narrow bands on the floodplains adjacent to streams. Flooding or ponding hazards limit the suitability of this soil for building sites. This association is used for small grain, hay, pasture, and grazing. Part of the area is irrigated.

An association of Yetull-Gollaher-Korchea soils is found on the nearly level to undulating terraces and floodplains along the Missouri River between Ulm and Great Falls. These soils are mainly deep, well drained loamy sands. Nonirrigated and irrigated small grain, hay, and grazing are the dominant uses of this association.

The Lepley-Benz-Marvan association is of minor importance in the alluvial lowland landscape unit of the Ulm District. These soils are used for grazing and nonirrigated small grain crops. The flooding and ponding hazard combined with slow permeability of these soils make them unsuitable for building sites and septic tank filter fields.

SLOPE - Gentle; 0 - 2%.

EXAMPLE AREA LOCATION - Ulm Flats, west and northwest of Ulm, Section 1, Township 19 North, Range 1 East, Montana Prime Meridian.

SUGGESTED POLICIES -

1. Low density activities, such as agriculture, shall be preferred because of the flood hazard.
2. Housing developments will be discouraged, and will not be allowed in designated floodplains. Soils which are prone to high groundwater are recommended for agricultural use only.
3. Hospitals, schools, subdivisions, rest homes, and commerical and industrial developments will be stricly prohibited from the floodplains.
4. All developments shall be reviewed by the appropriate agencies and the Citizen's Advisory Committee for impact on the environment.
5. Dikes, levees, and other methods of flood control will be considered a land use problem rather than an engineering problem.

RECOMMENDED ACTIONS -

1. Curtail man's activities except agriculture on the floodplains and floodways.
2. Map the floodway and floodway fringe for at least the 100 year flood.
3. Land-use controls should reflect the environmental limitations on the alluvial lowlands.
4. Areas of critical wildlife habitat should be acquired and administered by the Montana Department of Fish and Game.
5. Any further development should occur within existing community boundaries only.

SEDIMENTARY TERRACES OR BENCHES - LANDSCAPE UNIT

DEFINITION - The relatively flat or gently sloping topographic surfaces which mark former valley floor levels. Stream downcutting has caused the terraces to stand higher than the present valley floor. Terraces are traditionally composed of alluvial deposits of sand, silt and gravel. Some of the necessary gravels, however, have either not been deposited by the stream or have been subsequently eroded. Therefore, the term "bench" may be more appropriate. There are some remnant terrace sand, silt and gravel deposits throughout the county, so the terms "terrace" and "bench" may be used interchangeably throughout the plan.

EXTENT AND DESCRIPTION - Sedimentary terraces and benches are found about 100 feet above the valley floor around the 3500 foot contour. The upper limit of these relatively flat surfaces is about 3800 feet. Taft Hill northwest of Ulm is a prominent terrace or bench. The terraces have a steplike appearance with a relatively steep rise of 100 feet between "steps."

Agriculture is the primary use of this land, mainly for grazing and small grain crops. Some of the area near Taft Hill is used for wildlife purposes.

VEGETATION - Cultivation accounts for much of the vegetation in this landscape unit. Dryland farming, haylands and grazing are the primary land uses, and alteration of the natural vegetation is the result. Native grasses of the area include western wheatgrass, bluegrass, and bluebunch wheatgrass. Few trees are found in this landscape unit and brush is limited to the draws and coulees.

WILDLIFE - Big game animals found in this landscape unit include mule deer, whitetail deer, and antelope. Game birds such as pheasant, sharptail grouse and Hungarian partridge also inhabit the area. Various small animals, such as ground squirrels, may also be found in this landscape unit.

GEOLOGIC HAZARDS - Major hazards in this landscape unit include water erosion and wind erosion. Erosion is particularly evident where the terraces landscape unit meets the alluvial lowlands landscape unit, where water flows are at their highest. The wind averages of this area are among the highest in the nation and account for damages from blowouts and dune formation. Slumping is evident on a minor scale in some places.

CHARACTERISTICS -

GEOLOGY - Formations in this landscape unit are of the Cretaceous period (100 million years ago) with some Quaternary (3 million years ago) deposits. Major deposits from east to west include the Blackleaf formation which is a series of sandstone, siltsone and shales of varying colors, thicknesses and texture. The Marias River Formation is the other major group and it is composed mainly of black shales and black siltstones. Small pebble conglomerate formations can also be found in the Blackleaf Formation at some points.

Other deposits which can be found in the bench or terrace landscape unit include dune sands and terrace deposits. The sands are believed to be from nearby formations or glacial lake deposits which have been eroded by the wind. Terrace gravel is composed of well rounded, poorly sorted pebbles and cobbles which are believed to have been deposited during the Ice Ages of the Quaternary Period (3 million years ago). Presently they are the major gravel sources for the region.

SOILS - Tanna soils make up a large part of the sedimentary terrace landscape unit. These soils have a moderately light colored clay loam surface layer and a brown clay subsoil. The subsoil is calcareous below depths of 10 to 16 inches. This well drained soil has a depth to shale of 24 to 40 inches. The slow permeability and the depth to bedrock present limitations for use of this soil for septic tank filter fields. Nonirrigated small grain crops form the primary use of this association. The steep slopes and bench edges are used for grazing.

The Rough broken land association is dominated by steep land broken by numerous intermittent drainage channels. The soils are generally non-stony and range from shallow to deep. Runoff is high and geologic erosion is active. In the Ulm District, these soils are generally found in the Taft Hill area and the north side of the Missouri River. This association is used for grazing and wildlife purposes.

Azaar-Gollaher-Tally association soils are mainly dark colored, well drained, sandy soils found between Ulm and Great Falls. This

association is used mainly for grazing and nonirrigated small grain and hay.

The Winifred-Yawdim-Butchert association is of minor importance to the Ulm District. There is a problem with frost heave. Some areas are used for small grain and hay, although the primary use is grazing.

SLOPE - Steep scarp upslope followed by a rolling plain. Slope is highly variable, gentle (0 - 10%) on the plain, steep (over 25%) on the upslope.

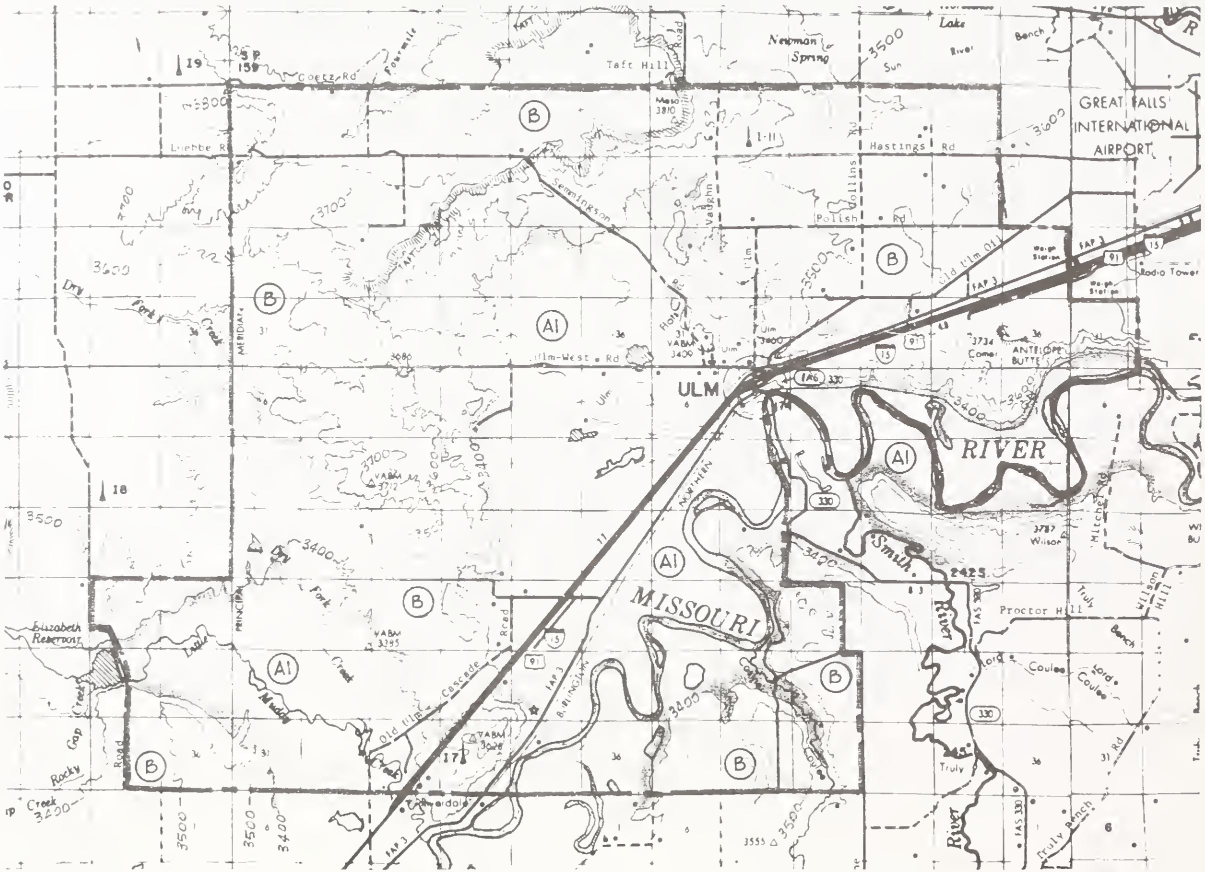
EXAMPLE AREA LOCATION - Taft Hill, northwest of Ulm in Sections 13, 21, 22, 23, 28, and 29, Township 20 North, Range 1 East, Montana Prime Meridian.

SUGGESTED POLICIES - Because of the variability of limitations, extensive on-site inspection and evaluation should be made by qualified professionals before any proposed action is taken.

1. Terraces are such that they can accomodate a wide variety of land uses.
2. Because present land uses are predominantly agricultural, special consideration should be given to this use.
3. Maintenance of natural vegetation should be a prime consideration in order to preserve the landscape, discourage erosion, and maintain wildlife habitats.

RECOMMENDED ACTIONS -

1. Develop land-use controls which reflect the environmental limitations and assets of the terrace.
2. Encourage development in a form which reflects environmenatl limitations and the natural landscape.



Ⓐ1 ALLUVIAL LOWLANDS Ⓑ BENCHLANDS CONTOUR INTERVAL: 100 ft

N
1 in = 2 mi

TOPOGRAPHY - LANDSCAPE UNITS

SECTION II

CRITICAL HAZARD AREAS

SECTION II - CRITICAL HAZARD AREAS

The intent of the hazard areas section is to identify and record areas of hazardous nature in Cascade County, and to establish a procedure whereby proposed uses of these areas can be examined by citizens and county planners in order to protect life and property.

This section of the environmental plan describes areas which could be or are known to be susceptible to mass movement, flooding or earthquake. Since these pose risks for the construction of buildings, utilities, roads and the safety of persons living in the area, policies and performance standards are suggested for the various areas involved.

Some or all of the following information is provided for each hazard:

a. General description
b. Classification of the hazard areas
c. Suggested policy and recommended actions
d. Performance standards
e. Possible procedure for identifying hazard areas

The recommended policies and performance standards should serve until adequate floodway management and delineation is accomplished. At this time there is little available information on hazardous areas in Cascade County. Areas that are prone to flooding are generally known but have yet to be officially delineated. Areas that are susceptible to mass gravity movements have not been mapped or documented.

FLOOD HAZARD AREAS

GENERAL DESCRIPTION - Flood insurance regulations differentiate two (2) types of flooding, the "floodway" and the "floodway fringe." The "floodway" is the flood channel that carries the fast moving flood waters and is the area where flood damage will be the greatest. The "floodway fringe" is the area inundated by rising waters. Damage in the floodway is caused by fast flowing currents, while damage in the floodway fringe is caused by water damage and deposition of mud. The Missouri River and some of the smaller creeks have been known to flood.

DEFINITIONS -

FLOOD - The temporary rising and overflowing of a body of water onto normally dry land.

FLOODPLAIN - A plain built up by stream deposition which may be submerged periodically by floodwaters.

FLOODWAY - The normal stream channel and that adjoining area of the floodplain needed to convey moving waters at flood stage.

FLOODWAY FRINGE - The area of the floodplain lying outside the floodway, but subject to periodic inundation from flooding.

CLASSIFICATION OF FLOOD AREAS - There have been no designations prepared to classify lands in flood prone areas at this time. These designations are presently being considered: flood areas, floodway, and floodway fringe.

SUGGESTED POLICIES -

1. Housing and industrial developments should be discouraged in areas identified as flood prone.
2. Problems with flood prone areas should be handled as land-use considerations, not as engineering problems.
3. Hospitals, nursing homes and schools should be prohibited in flood prone areas.
4. Through the use of performance standards and floodplain regulations, agriculture, horticulture, and other open space uses should be encouraged.

RECOMMENDED ACTIONS -

1. All developments and subdividing of land should be discouraged, until floodplain designations are finalized.

2. A floodplain information and management plan should be developed by the county to inform the citizens of the hazards in these areas.

SUGGESTED PERFORMANCE STANDARDS -

1. The construction of access roads, embankments and fill should not impede the natural surface drainage pattern unless the express purpose of the construction is to impound waters.

MASS MOVEMENTS

GENERAL DESCRIPTION - Mass movement is the downslope movement of material in response to gravity. Because of the nature of some areas of the county, there exists the potential for the mass movement of earth and rock. Contributing factors to the problems of hazardous mass movements include slope, geology, soils, vegetation, rainfall (intensity and duration), man-made and natural disturbances and the variable relations and combinations of these factors. Magnitude and material content of mass movements vary with location and can be characterized by rock fall, soil creep, earth flow, slumping, bedding plane failure, debris slide or flow, or mudflow.

Slumping and soil creep are the most common forms of mass movement in the Ulm Planning District. Mass movements of this type often occur between terrace levels in the terrace and benches landscape unit and also between the alluvial lowlands and the terrace and benches landscape units. Rock falls and debris slides may occasionally occur in the vicinity of Taft Hill.

DEFINITIONS -

BEDDING PLANE - The junction plane between two (2) strata or layers of rock.

BEDDING PLANE FAILURE - Sliding along planes of weakness where bedding planes are parallel to the dip (slope). When only rock is involved the term "rock glide" may be used.

DEBRIS SLIDE - Rapid downslope movement of loose rock or soil on steep slopes.

EARTH FLOW - The movement of a mass of soil or of rock and soil. A scarp usually develops on the uphill side of the flow and soil, rocks and vegetation are mixed together. Shallow sag ponds and irregular drainage patterns are common.

MUDFLOW - The rapid, relatively fluid flow of soil and rock under conditions of excessive saturation.

ROCK FALL - The process by which rock becomes detached from a nearly vertical slope resulting usually in a talus slope.

SLUMPING - The process by which a more or less continuous mass of earth slips downhill along a curved basal slip plane in such a way that the mass of earth rotates backwards, toward the slope. The top surface of a slump frequently has a backward slope with a scarp on the uphill side and a toe on the downhill side. This is usually a relatively rapid movement.

SOIL CREEP - The very slow downslope movement of soil and weathered residuum. Frequently, this type of movement can be identified by the bowing of trees or the tilting of fences and untility poles.

For the most part, mass movement areas are easy to identify, as very unique landscape results. However, where the movement is very slow or is located a distance from the sight, identification becomes much more difficult. In addition, movment may be initiated or accelerated by man's activities. Construction activities and facilities frequently change the surface drainage, the infiltration of water, and the load, thereby increasing the risk of movement. Excavation can expose a bedding plane that is susceptible to movement or may oversteepen slope. Cutting the toe off an old slide can make it unstable and reinitiate movement.

CLASSIFICATION OF MASS MOVEMENT AREAS -

1. Critical mass movement areas - Areas that currently display mass movement.
2. Potential mass movement areas - Areas which have displayed mass gravity movement in the past and have the potential to become active. These areas may be suitable for limited development but extensive on-site evaluations should be performed prior to any action.

SUGGESTED POLICIES -

1. Hospitals, schools, nursing homes and community centers should be prohibited in areas displaying mass movements.
2. Purchasers of land in areas designated as subject to mass movement should be informed of the potential hazards inherent to those areas.
3. All construction activities should be discouraged in areas presently expressing mass movement or a high potential for such.
4. Potential development of areas of landslide topography should be scrutinized to assess its affect on the land; those uses which may have a detrimental affect should be discouraged.
5. Extensive on-site investigations should be made by a competent expert to determine where a potential hazard exists.

RECOMMENDED ACTIONS -

1. An effort should be made to accumulate all available geologic information and develop maps designing potential mass movement areas in Cascade County.
2. Performance standards should reflect the environmental constraints of mass movement areas.

3. Efforts should be made to inform potential buyers of the inherent hazard areas.

SUGGESTED PERFORMANCE STANDARDS -

1. No new structures should be permitted in areas identified as critical mass movement areas.
2. No cut and fill operation should be permitted.
3. In areas of potential mass movements, a site inspection should be carried out by a soils engineer or geologist.

PROCEDURE FOR IDENTIFYING MASS MOVEMENT -

1. Existing reports
2. Field investigations by qualified professionals
3. Montana State Highway Department - Engineering Division

SECTION III

OPEN SPACE

SECTION III - PUBLIC OPEN SPACE

PART I - EXPLANATION

Open space in all of its many forms has increased in importance to such a degree that it has gained recognition as one of the major resource management functions. The contributions of open space to human well-being are becoming widely recognized, and public awareness of dwindling open space resources is growing. As the population and attendant urbanization proliferates, so privacy, solitude, and the availability of uncrowded recreational areas become more elusive. In addition, public attitudes are becoming more sophisticated in accepting the importance of the various ecological functions of certain areas when kept in their natural state. The new attitudes extend to the recognition that some areas are inherently unsuitable for development because of geologic or climatic instability, and that these areas should be preserved in open space because of the potential hazards to human life or property.

Because of their financial dependence on property tax, local governments have typically favored development over the preservation of land as open space, but the belief that tax rolls are benefitted more by development is currently being subjected to critical reexamination as a result of recent studies. A number of these studies concluded that to allow land in certain areas to be developed would prove more costly to the public than to acquire the land for public open space. Furthermore, the economic arguments used formerly to promote development or to oppose open space proposals are no longer being accepted at face value by the public or local governments.

In the environmental plan, public lands which posses significant existing or potential value for public open space purposes are identified and recommended for preservation for future open space uses. In arriving at the individual sites being proposed in the open space plan, such factors as access, usability, vegetation cover, open areas, water use potential, view and vistas, slope and land use conflicts, historical value, and recreation were considered. It must be remembered that sites shown in the plan are not the only possible sites and may warrant adjustment or deletion as time and other factors may dictate.

It is our objective in this section to identify and classify existing and potential open space areas in the Ulm study area, along with suggested goals, policies, and recommended actions for the Citizen's Advisory Committee and the Board of County Commissioners to consider.

PART II - DEFINING OPEN SPACE

The term "open space" is an abstraction which eludes simple definition. Open space may be defined legally, as for legislative purposes; or functionally, defining a use for space.

A. LEGAL DEFINITION OF OPEN SPACE:

Some ordinances and laws have defined open space for a number of purposes. Some definitions indicate types of land for which local governments can receive grants. Others indicate types of land to be considered in the preparation of local open space plans.

The federal definition of open space is contained in the open space provisions of the Housing Act of 1961: "The term 'open space land' means any undeveloped or predominately undeveloped land in an urban area which has value for (a) park and recreation purposes, (b) conservation of land and other natural resources, or (c) historic or scenic purposes."

Montana's model subdivision regulations define open space as "A land or water area devoid of buildings and other physical structures except where accessory to the provisions of recreation."

B. FUNCTIONAL DEFINITION OF OPEN SPACE:

Open space is often identified as land which does or can serve some use as open space. For example, Cascade County's Subdivision Regulations contain the following:

> "Common Open Space: A parcel or parcels of land, or an area of water, or combination of land and water within a planned unit development designated or intended for the use or enjoyment of residents within the development."

In this context the definition consists of the function which open space serves. In the Cascade County Open Space Program, the following open space functions will be used to organize both the inventory of the county's open space resources and the set of findings and policies regarding open space:

1. Open space for recreation; parks, park lands, trails, and water areas.
2. Open space for the protection of scenic resources; scenic backdrops, scenic roads and highways, and scenic water areas.
3. Open space for the protection of wildlife and vegetation.
4. Open space for the protection of historic, archeological and scientific resources; historic landmarks and archeological sites.

In all likelihood, not all of the above open space designations will be used in any one (1) planning district.

PART III - NEED FOR OPEN SPACE

Residents in Cascade County are fortunate in that they are within easy travel distance of many recreational opportunities. Glacier National Park; Holter, Hauser, and Canyon Ferry Reservoirs; the Missouri, Sun, and Smith Rivers; Showdown Mountain Ski Area; the Bob Marshall and Gates of the Mountains Wilderness areas; and a rather large portion of the Lewis and Clark National Forest are right on the doorstep. According to the State of Montana Fish and Game Commission demand (in terms of occasions per weekend) for Region 5 was 185,300 activity occasions. Region 5 includes Glacier, Toole, Pondera, Chouteau, and Cascade Counties. The increase demand projections for selected activities by 1990 are:

Camping - 44%	Hiking - 46%
Picnicking - 23%	Driving - 22%
Boating - 48%	Sight-seeing - 29%
Swimming - 38%	Walking - 28%
Fishing - 18%	

At present, excluding Glacier National Park, the following facilities are in Region 5:

1) 57 picnic units
2) 141 camping units
3) 1 swimming unit
4) 16 fishing access sites
5) 4 boat ramps

With population growth and increasing amounts of leisure time, a growing demand for open space and recreation activities seems to indicate a need for additional facilities. There is a lack of facilities close to the smaller communities. Facilities suitable for day use activities in areas of a natural environment are deficient, especially near Great Falls.

This demand can be met only be designating and setting aside land, both public and private, to be used and developed into future recreational and open space sites. Designation and reservation of land should begin as soon as possible as the demand for residential as well as other types of development is likely to occur simultaneously.

Areas which should receive special attention:

1. Fishing access and camping sites along the Missouri River.
2. Ulm Pishkun in Taft Hill area.

A. OPEN SPACE FOR RECREATION:

FINDINGS -

1. Because they are held in public ownership, parks are a permanent form of open space that can be counted on to endure from generation to generation.
2. The private sector can play an important role in providing recreational open space areas.
3. Open space recreational developments, if not properly designed, may have an adverse effect on natural resources and the environment in general.
4. Projects of special districts (e.g. flood control districts) and utility companies can sometimes be designed and constructed to include trails along the right-of-way of the project.
5. Recreational activities on rivers and streams, if not properly regulated, can be harmful to important wildlife species and wildlife habitat areas.

SUGGESTED GOALS -

1. Develop and maintain recreational opportunity for groups of all ages.

SUGGESTED POLICIES -

1. Proposed recreational developments that may have an impact on the environment shall be carefully designed and reviewed and environmental impact assessments should be made.
2. Use of off-road motorized vehicles shall be generally prohibited in open space areas.
3. Additional public access and appropriate recreational facilities shall be provided along the river.
4. Provide recreational facilities capable of promoting the health, safety, morals and general welfare of all classes of individuals within the region.
5. Certain lands in public ownership shall be set aside for future use and development as open space, as there is a need for them because of population and industrial growth.
6. Land exchanges between public agencies and private owners shall be encouraged for the acquistion of open space when applicable.
7. Provide a diversified year-round recreation plan and program to serve the residents of Cascade County.

8. Recognize the potential of the region as a tourist recreation area and provide for a balanced development of tourist oriented faciliites which will enhance and stabilize the region's economic base.
9. Water-dependent recreational development shall be considered a priority use.
10. Water-dependent recreational development providing public access shall be given preference over similar development which limits public access or use.
11. Recreational development and use shall not exceed the carrying capacity of the land.
12. Adequate public access to river and stream resources shall be provided.
13. Public access roads and trails shall be provided to areas currently in public ownership.
14. Use existing public land for open space before acquiring additional sites.

RECOMMENDED ACTIONS -

1. Local and state governments should work actively to provide parks and other recreational open space.
2. Provisions should be made to encourage the private sector to enter the field of outdoor recreation.
3. Programs for park acquisitions and development should include lands for trails. Trails should be built as soon as possible after acquisition, using volunteer help for construction and maintenance wherever possible.
4. The State Division of Highways should be urged to include right-of-ways for bicycle trails where appropriate along state highways.
5. State, federal, county, and city park and recreation agencies should be encouraged to coordinate their efforts.
6. Additional study should be done to determine a stable and continuing source of funds for park acquisition and development of appropriate scale to adequately support anticipated needs for recreation and park service.
7. A map listing fishing access sites should be developed cooperatively by the County Planning staff and the Montana Fish and Game Commission.

B. OPEN SPACE FOR THE PROTECTION OF SCENIC RESOURCES:

FINDINGS -

1. Cascade County is rich in number of roads and highways traversing scenic rural areas. Leisurely travel on these roads is a valuable recreation and open space experience. Some roads should be given protection against defacement by scenic highway zoning.
2. Increasing travel on scenic roads may greatly diminish their value.
3. The scenic value of water areas can be greatly diminished if development is allowed to encroach upon them.
4. Open spaces within the urban area are valuable for the scenic enjoyment of urban dwellers.

SUGGESTED GOALS -

1. Encourage preservation of the scenic beauty and natural environment.

SUGGESTED POLICIES -

1. River access shall be maintained for public use.
2. Great care shall be taken to protect the character of scenic roads.
3. Areas adjacent to bodies of water shall be protected for their value as scenic open space.
4. Maximum pedestrian access shall be provided for scenic enjoyment of the open water; sloughs, marshes, and rivers - except for natural areas protected for their scientific and educational value.
5. All county lands to be sold at public auction into private ownership should be reviewed by the Cascade County Planning Board and Citizen's Advisory Committees for potential use as public open space lands before said sale.
6. Use of land for open space shall be considered a priority use of the study area.
7. Wherever practicable, open space shall be enhanced and protected to insure retention of the existing local character.
8. Scenic vistas of the study area shall be designated and protected.

RECOMMENDED ACTIONS -

1. There should be a study of scenic roads to determine their suitability for recreation trails, turnouts, and parking areas.
2. Where appropriate, scenic easements should be acquired from private landowners.
3. The county should provide standards and programs for maintenance of open space and protection of scenic areas through development criteria.

C. OPEN SPACE FOR THE PROTECTION OF WILDLIFE AND VEGETATION:

FINDINGS -

1. Open space areas are important to wildlife in providing them with the food, resting, and nesting areas needed for their survival.
2. Each species of wildlife is adapted to and dependent upon a particular set or range of habitat conditions for its survival. Some species can survive urban or suburban areas, but others can survive only if their habitat is preserved in its natural state, largely undisturbed by man. Even those which can survive in urban areas may be able to do so only so long as there remains within the urban area predominately natural areas, such as wooded stream sides, where they can find refuge and their other survival needs.
3. Several species of wildlife in Cascade County are included on the U.S. Department of Interior's list of rare and endangered species. If their habitat areas are not carefully protected, these species may become extinct.
4. The opportunity to observe and study wildlife in their natural habitat is a source of leisure time enjoyment to many residents of the county. Human intrusion into wildlife areas, however, can have adverse impact upon wildlife and their habitats.
5. Vegetation performs a number of important open space functions, including:
    (a) Providing scenic beauty
    (b) Serving as habitat for wildlife
    (c) Preventing soil erosion
    (d) Maintaining air quality
    (e) Controlling water runoff in watershed areas
6. Certain types of recreational activity, such as the use of off-road vehicles, can adversely affect vegetation in open space.
7. Natural vegetation is an irreplaceable educational resource as it allows study of features and conditions of natural environmental balances.

RECOMMENDED ACTIONS -

1. Retention of vegetation in both urban and nonurban areas should be a major objective of local open space and environmental policies.

D. OPEN SPACE FOR THE PROTECTION OF HISTORIC, ARCHEOLOGICAL AND SCIENTIFIC RESOURCES:

FINDINGS -

1. Historic landmarks and archeological sites may be lost if they are not protected from urban development.

SUGGESTED GOALS -

1. Preserve, develop, and maintain historical, educational and natural sites.
2. The overall goal in developing policies regarding historical and archeological resources is to preserve as a living part of the life and development of the local area, region, state, and nation the rich heritage of our past that might otherwise be lost due to unnecessary and unwise development.

SUGGESTED POLICIES -

1. Both public and private efforts shall be directed to preserve historical landmarks which have open space potential.
2. Areas and sites of archeological significance shall be protected from development.
3. The public interest in areas of unique historical, scenic or archeological significance shall be recognized in considering development in these areas.

RECOMMENDED ACTIONS -

1. Historical and archeological resources should be inventoried and protected.
2. The county should evaluate the impact of development upon historical and archeological resources prior to approval or disapproval of the project.

PART IV - IMPLEMENTATION

The following implementation techniques offer possible ways of acquiring future open space in Cascade County assuring the maintenance of our rural quality of life.

1. Property Donation. Property donation is a way for an individual to give the county a piece of property for whatever reason he wishes. Should this property be suitable for open space use, the county could keep it in reserve for future use. This, of course, is a voluntary method of acquiring open space land.

2. Property Exchange. When the county wants a piece of property which is owned by a private individual or corporation, the county can offer to exchange part of the land now in public ownership for this privately owned parcel.

3. Conservation Easement. A conservation easement is a piece of land privately owned on which certain rights have been sold or donated to the city, state, or county by the owner. The rights sold or donated would be tied to the land and would forbid certain types of building and development. This would be a voluntary agreement between the public body and the private individual.

4. Sale-back and Lease-back. In this method of acquiring land for open space, the county buys the land outright and places property restrictions and convenants on the land. The land is then sold or leased back to the private sector.

5. Cluster Development. This system allows the county and land developer to negotiate an agreement whereby the developer may increase the density beyond the stated maximums in the county zoning ordinance on one part of his property and leave another part free from development as publicly dedicated open space.

6. Club or Group Involvement. Civic, service and garden clubs, Boy Scouts and military construction units, can make important voluntary contributions to public recreation areas. When a park development plan is available, such groups can concentrate on projects which interest them and gradually bring about improvements to facilities even when public funds are not available.

7. Private Recreation Facilities. When private facilities answer an obvious public need and are properly managed, the county should encourage and supplement, rather than duplicate them.

8. Easement, Lease, Development Right Purchase. The purchase of development rights is one device for keeping land in its existing condition. The owner may continue to use the land as he has in the past but may not develop it for some new, more intensive use.

9. Use of Tax Foreclosed Land. In undeveloped areas where recreation areas are needed, the possibiltiy of utilizing tax foreclosed lands should be investigated. In some cases, lands owned but not used or needed in the future by some other governmental agency may also be put to temporary or permanent recreational use.

10. Continuing Levy. An alternative to a special election for open space acquisition is to obtain voter approval for continuing levy to be applied to open space acquisition. This assurance of a regular annual revenue permits a broader development program to be planned and accomplished.

11. Federal Financial Assistance. A number of federal programs have been established which might prove helpful to the county in financing open space acquisition and improvement.

12. Fee Simple Acquisition. Acquiring land outright for open space by the use of federal, state, or local funds, is another method of acquiring open space lands.

SECTION IV

PRIORITY RESOURCES

SECTION IV - PRIORITY RESOURCES

The purpose of this section of the plan is to identify priority resource areas within the district and to provide a sound policy foundation for conservation policies. Priority resources may be defined as lands containing natural resources of either existing or potential economic value. The criterion for identifying priority resources is any resource which serves an important economic function. Included as priority resources in the Ulm Planning District are: agricultural lands; fisheries; minerals and mineral aggregates; and water resources.

AGRICULTURAL LANDS

Agriculture is the primary land use in the Ulm Planning District. The area contains some excellent irrigated lowlands, dryland grain farms and pasturage for livestock. Sprinkler irrigation has recently been introduced on some of the dryland farms bringing higher production rates to the area.

Certain parts of the district are presently being transformed from agricultural to suburban and rural residential areas. (The Ulm area is a notable example.) Lands in transition are probably not the most agriculturally productive, but as encroachment upon these areas continues, adjacent or nearby agriculturally productive lands are pressured by the higher values of residential and industrial uses. Eventually they succumb to futher development and further loss of agricultural land.

SUGGESTED POLICIES -

1. Rather than allow indiscriminate leap-from subdivision and development, residential subdivision should be developed in clusters near or adjacent to present residential areas.
2. Efforts should be made to preserve lands now under irrigation; including those lands which have a high potential for being irrigated at some future date.
3. Floodplains should be left for agricultural and open space uses.
4. The aesthetic value of agriculture should be recognized and agricultural uses should be encouraged along scenic corridors.
5. Local land-use planning should encourage the continuance of agriculture as a functioning part of the local economy.
6. Agricultural activites and practices which are compatible with the physical suitability and landscape of the planning district should be encouraged.

RECOMMENDED ACTIONS -

1. Local governments and others should discourage conversion of agricultural land to urban uses unless it is an orderly and necessary extension of an existing land use.

FISHERIES

Although not directly a land resource, sport fishing is directly or at least partially affected by activities on the land adjacent to water bodies. Commerical fishing is not and probably will not be an important industry in the near future in Cascade County. The Missouri River is classified as a cold water sport fishing stream.

SUGGESTED POLICIES -

1. No waste shall be discharged into any waters without first receiving the treatment necessary to protect the fisheries resources.
2. Buffer strips should be encouraged to keep debris out of active flowing streams.
3. Rechanneling of streams should not be allowed.
4. Adequate flows shall be maintained in streams in order to provide habitat for fish.

RECOMMENDED ACTIONS -

1. The county should establish an environmental assessment procedure requiring extensive on-site investigations before any development takes place within 100 feet of the river bank. These assessments should be made public and reviewed by qualified technical personnel to judge their accuracy.
2. Minimum stream flows should be established to protect and provide habitat for fish.

MINERALS AND MINERAL AGGREGATES

Sand, gravel, and crushed rock are important factors in the development of any community. These mineral aggregates are used in the making of portland cement concrete, asphaltic concrete, foundations for roads as well as select fill and are used extensively in concrete for large structures such as bridges and multi-story buildings. There are several areas in the planning district where sand and gravel are presently or have been mined with extensive areas having the potential to produce building material.

Other potential minerals found in the area are bentonite, sandstone, and alluvial clay. Bentonite or bentonitic clay is used for lining and sealing reservoirs and sewage lagoons because of its high shrink-swell nature. Sandstone in small amounts is used for foundations, well linings, decorative stone, and riprap for facing on small stock dams. Some of the alluvial clay in the Missouri Valley has ceramic properties although it is not present in sufficient quantity to be of economic importance. There are no identified coal deposits. Potential for oil and gas production in this area is minimal at best.

SUGGESTED POLICIES -

1. Because mineral resources are in short supply, all known areas of economic potential should be protected from any type of development that would conflict with extraction activities.
2. Require reclamation of areas after mining is completed.
3. Require an Environmental Impact Statement.

RECOMMENDED ACTIONS -

1. The county should identify areas having economic potential.
2. The available mineral resources should be exploited to the fullest; extraction should be encouraged if it is the highest and best use of the land.

WATER RESOURCES

The Missouri River flows through the Ulm Planning District from southwest to northeast and is the greatest supply of water for the region. Little development of irrigation has taken place within the area.

Irrigation projects presently in use can be found on Little Muddy Creek where several storage reservoirs have been built. Small scale projects, often of the pump and sprinkler type, have been developed at several spots along the Missouri River.

Groundwater resources in the area have a high potential for future development. Little development has taken place at present because the best aquifers are beyond economic drilling depths. The Kootenai Formation, which is one of the better aquifers in Montana, is quite deep in Cascade County. Other aquifers within economic drilling depth are undependable or of insufficient quantity.

SUGGESTED POLICIES -

1. No out of basin appropriation of the waters of the Missouri River Basin shall be considered without the prior approval of, and following the public hearing in the subject basin by the State Water Resources Board.
2. Rights to the use of water shall be granted only on the condition that any effluents or return flows shall not interfere with other beneficial uses of water.

RECOMMENDED ACTIONS - If the streams in the study area are to remain an important resource, care must be taken to preserve this valuable commodity. As streams reach their low annual stream flow during the summer months, care must be taken to insure that the stream flow does not fall below the recommended minimum flow necessary to support aquatic life. State agencies should also regulate the issuance of water rights so as to insure that the total water rights of a stream do not exceed the minimum stream flow.

MISSOURI RIVER MAIN STEM
Missouri River near Ulm, MT

LOCATION - Lat 47°26'09", long 111°23'07", in NE¼NW¼NW¼ sec. 5, T.19 N., R.3 E., Cascade County, on left bank 5.6 mi (9.0 km) east of Ulm and 9.1 mi (14.6 km) downstream from Smith River.

PERIOD OF RECORD - August 1957 to 1974.

AVERAGE DISCHARGE - 17 years, 6,564 ft^3/s* (185.9 m^3/s), 4,756,000 acre-ft/yr (5.86 km^3/yr).

EXTREMES - 1974: Maximum discharge, 20,000 ft^3/s (566 m^3/s) June 22, gage height, 12.09 ft (3.685 m); minimum daily, 3,220 ft^3/s (90.6 m^3/s) Oct. 1.

Discharge, in cubic feet per second, water year October 1973 to September 1974.

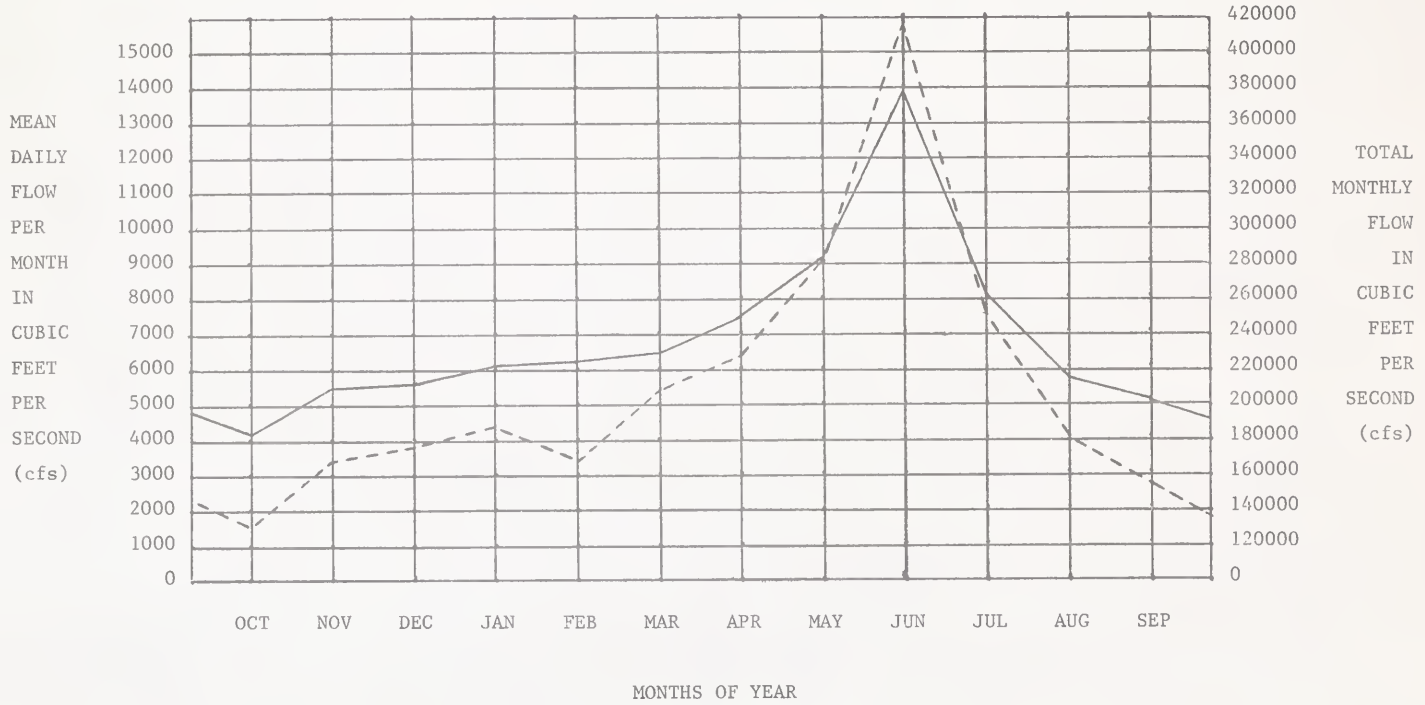
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
TOTAL	132,080	168,430	178,160	188,050	172,860	210,200	229,020	283,350	419,910	248,800	182,620	156,600
MEAN	4,261	5,614	5,747	6,066	6,174	6,490	7,634	9,140	14,000	8,026	5,891	5,220
MAX	4,990	6,030	6,000	6,600	6,660	7,400	10,300	12,600	19,900	17,600	7,140	6,730
MIN	3,220	5,080	5,450	5,100	5,800	5,890	6,060	7,560	9,860	5,510	4,330	4,260
AC-FT	262,000	334,100	353,400	373,000	342,900	399,100	454,300	562,000	832,900	493,500	362,200	310,600

CAL YR 1973	TOTAL 1,703,630	MEAN 4,667	MAX 6,950	MIN 2,240	AC-FT 3,379,000
WTR YR 1974	TOTAL 2,561,080	MEAN 7,017	MAX 19,900	MIN 3,220	AC-FT 5,080,000

NOTE - Stage-discharge relation affected by ice Jan. 1 to Feb. 11.

* ft^3/s - cubic feet per second.

MISSOURI RIVER MAIN STEM
Missouri River near Ulm, MT

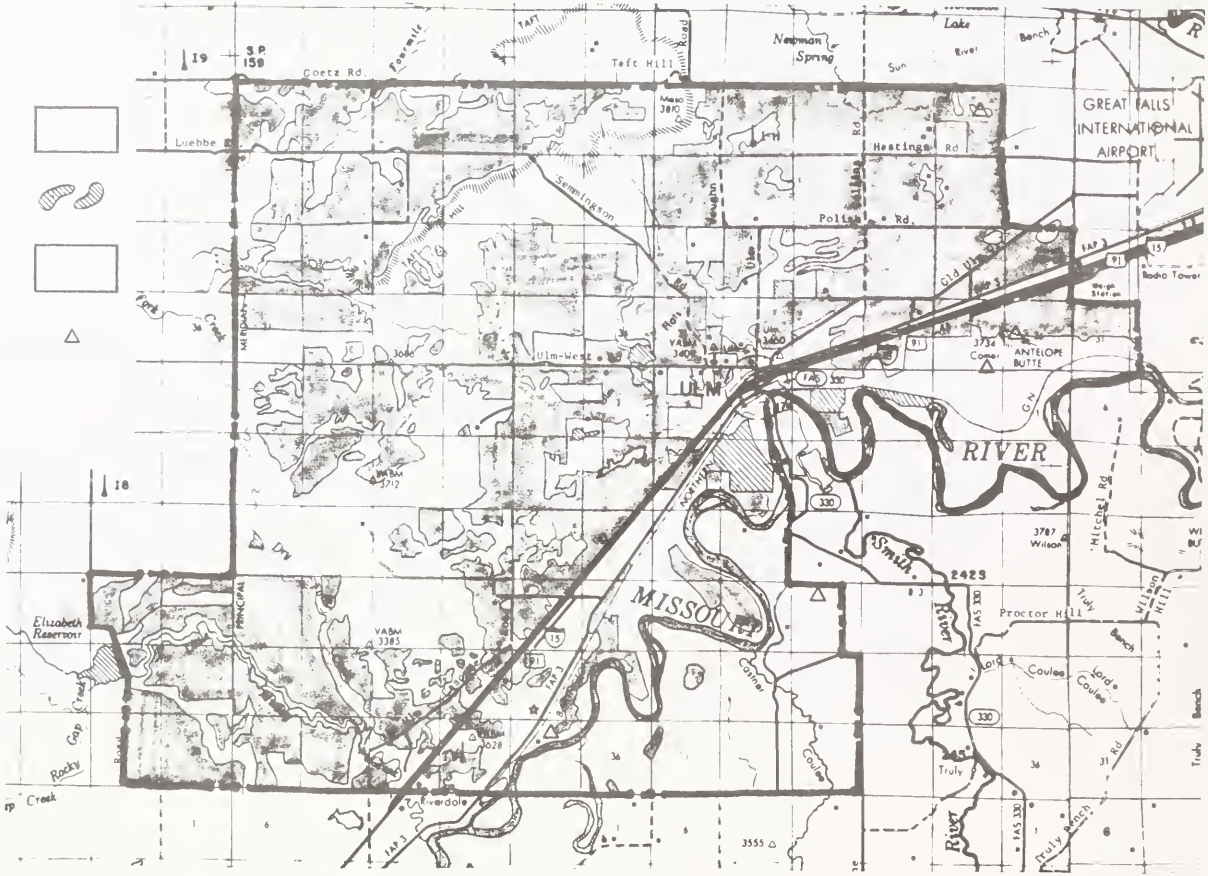


DRY LAND FARMING

HAY LAND

GRAZING

GRAVEL PIT △



PRIORITY RESOURCES

APPENDIX A

DEFINITION OF LANDSCAPE UNITS

DEFINITION OF LANDSCAPE UNITS

RIVERS, STREAMS, LAKES AND RESERVOIRS

Lakes, reservoirs and rivers include water bodies either flowing or standing for all or most of the year. Included in this landscape unit are those lands immediately adjacent to water bodies which directly influence the physical, biological and chemical properties of the water.

ALLUVIAL LOWLANDS

The alluvial lowlands are plains occupying valley floors which result from the deposition of material by water. The major conspicuous feature of this landscape unit is the floodplain.

SEDIMENTARY TERRACES OR BENCHES

The relatively flat or gently sloping topographic surfaces which mark former valley floor levels. Stream downcutting has caused the terraces to stand higher than the present valley floor. Terraces are traditionally composed of alluvial deposits of sand, silt and gravel. Some of the necessary gravels, however, have either not been deposited by the stream or have been subsequently eroded. Therefore, the term "bench" may be more appropriate. There are some remnant terrace sand, silt and gravel deposits throughout the county, so the terms "terrace" and "bench" may be used interchangeably throughout the plan.

SEDIMENTARY FOOTHILLS

The foothills lie between the sedimentary terraces and the igneous uplands. The lower parameter is the 4000 foot contour line and the upper parameter, the break between foothills and uplands, is the 5000 foot contour line.

IGNEOUS FOOTHILLS

The igneous foothills occupy the area between the sedimentary terraces and the igneous uplands. The lower parameter is the same as the sedimentary foothills, the 4000 foot contour. The upper parameter corresponds with the 5000 foot contour line.

SEDIMENTARY UPLANDS

The uplands landscape unit occupies much of the extreme southern part of the county with the 5000 foot contour as its

lower parameter. Sedimentary uplands are those uplands composed of rock strata deposited by inland seas which once occupied the area.

IGNEOUS UPLANDS

Igneous uplands are those areas underlain by igneous material and over 5000 feet in elevation.

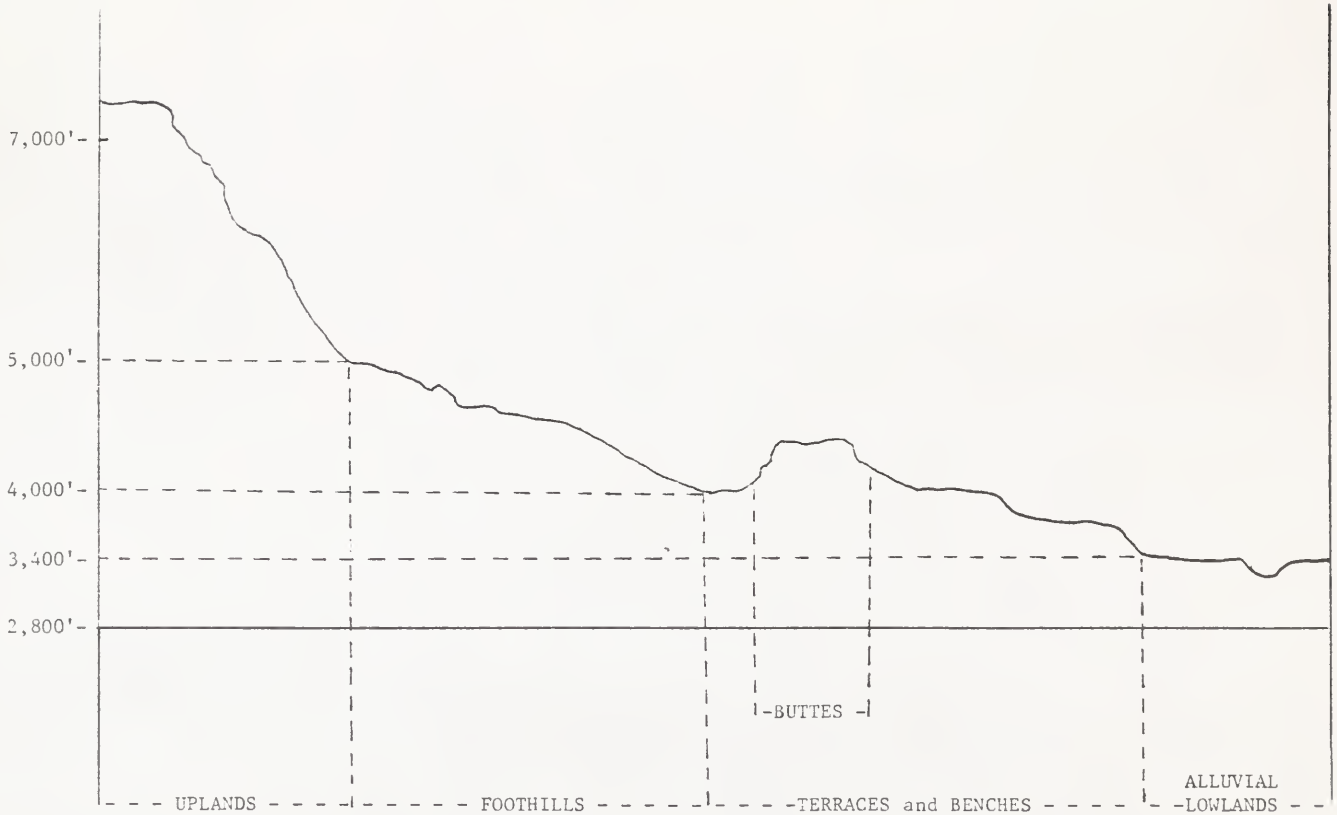
METAMORPHIC UPLANDS

In Cascade County the metamorphic uplands landscape unit includes those areas geologically altered by volcanic or other activity. Metamorphic or metamorphism implies a pronounced change effected by heat and pressure resulting in a more compact, highly crystalline condition.

BUTTES

Buttes are the many conspicuous hills with steep or precipitous sides which are visible north of Cascade or south of Simms and Fort Shaw. Differential erosion has caused the more resistant capped buttes to stand taller than the surrounding landscape.

LANDSCAPE UNITS IN CROSSECTION



APPENDIX B

GEOLOGIC TIME SCALE

GEOLOGIC TIME SCALE

	NAME	IMPORTANT EVENTS IN NORTHERN ROCKIES
	Pleistocene Epoch	Ice ages and widespread volcanic activity
	- - - - - - - - - - - - BEGAN ABOUT 3 MILLION YEARS AGO - - - - - - - - - - - -	
	Tertiary Period	Valley-fill deposits laid down during time of desert climate. Mountain building, volcanic activity, intrusion of granites.
	- - - - - - - - - - - - -BEGAN ABOUT 60 MILLION YEARS AGO - - - - - - - - - - - -	
MESOZOIC ERA	Cretaceous Period	Beginning of formation of Rocky Mountains
MESOZOIC ERA	Jurassic Period	Volcanic activity, intrusion of granites
MESOZOIC ERA	Triassic Period	Deposition of Mesozoic sedimentary rocks
	- - - - - - - - - - - - -BEGAN ABOUT 225 MILLION YEARS AGO - - - - - - - - - - - -	
PALEOZOIC ERA	Permian Period	Deposition of Palezoic sedimentary rocks
PALEOZOIC ERA	Pennsylvanian Period	Formation of coal beds
PALEOZOIC ERA	Mississippian Period	
PALEOZOIC ERA	Devonian Period	
PALEOZOIC ERA	Silurian Period	
PALEOZOIC ERA	Ordovician Period	
PALEOZOIC ERA	Cambrian Period	
	- - - - - - - - - - - - -BEGAN ABOUT 600 MILLION YEARS AGO - - - - - - - - - - - -	
PRECAMBRIAN ERA		Deposition of Precambrian sedimentary rocks
PRECAMBRIAN ERA		Formation of Precambrian igneous and metamorphic basement rocks
	- - - - - - BEGAN ABOUT 3000 MILLION (3 BILLION) YEARS AGO - - - - - - - - - -	

APPENDIX C

ENDANGERED SPECIES

ENDANGERED SPECIES FOUND IN MONTANA

BLACK-FOOTED FERRET - may possibly be found in Cascade County but no research has yet been done.

PEREGRINE FALCON (Duck Hawk) - may be found in Cascade County but is very rare.

WHOOPING CRANE - none found in Cascade County.

NORTHERN ROCKY MOUNTAIN WOLF - none known in Cascade County.

The Black-footed Ferret is an extremely rare animal that eats prairie dogs. Its primary danger is that it may be poisoned when prairie dogs are poisoned.

Poisoning is also a threat to the Peregrine Falcon. Certain insecticides, such as DDT, concentrate as they move up through the food chain. The Peregrine Falcon is at the top of one such food chain where concentrations are very high.

APPENDIX D

ALTERNATIVE ENERGY

ALTERNATIVE ENERGY

The 1970's have introduced a new public awareness of the problems plaguing energy production in the United States. Shortages caused by excessive demands, political variables, and depletion of nonrenewable natural resources have shown that we are facing an uncertain energy future. Because planning is preparing for the future, alternative energy sources which are compatible to the environment and the public of Cascade County should be analyzed.

Present energy consumption within the county is mainly hydroelectric and natural gas. Various petroleum products are produced in local refineries and include transportation fuels and heating fuels. Wood is primarily used in the area for supplementary heating, but inefficient fireplace systems waste much of its potential.

Natural resources available within the county but undeveloped include coal, possible natural gas, sun and wind. The advantages and disadvantages of each resource are listed on the included energy resource cost chart. Energy resources are listed on the included energy resource cost chart. Energy resources unavailable in Cascade County but of importance to the nation are also listed.

Implementation of alternative energy methods generally falls into two (2) categories: private and public. Alternative private energy resources which can be developed on an individual basis include: solar heating, wind electrical generation, wood, and various others. This appendix will stress individual rather than community projects.

Because our conventional energy and fuel sources (oil, coal, natural gas and uranium) will not last forever, two (2) realizations must be made. The first is that we must slow down the consumption of such energy sources. The second is that we must find alternative sources to satisfy our tremendous energy appetite. In deciding which alternative energy source to use we must choose those which would be the least costly and of the most benefit to America in the long run.

Following is a description of some of the nonrenewable and limited sources of energy available to the nation. Many of these are not located within Cascade County.

Nuclear Fission: Uranium is the fuel for these power plants and it is already in short supply. None is known to exist in Cascade County. Liquid Metal Fast Breeder Reactors are being developed which create more fuel than they can consume. Many think they are the hope for the future but they are still very controversial. Extremely high operating temperatures could cause explosions of poisonous material, and wastes generated by the system are difficult to dispose of.

Coal Gasification and Liquification: Coal reserves are a potential short term energy source in Cascade County. Commercial mining of this mineral was started as early as 1876 but has since been discontinued. Strippable deposits are located under much of the southern and eastern parts of the county. The environmental and social costs of developing this resource would be high.*

Oil Shale: Development of the oil shale in western states would impose heavy environmental costs in disruption of the land and in visual, air and water pollution. Not only is the waste material enormous but it would be of considerably greater volume than the original shale. Huge amounts of water are also needed. No oil shale is known to exist in Cascade County. This energy source is nonrenewable and is exhaustible although it would yield tremendous volumes of oil.

Petroleum: Development of this source has been extensive and known resources are being depleted in the U.S. As of 1976, forty-one percent (41%) of all crude oil consumed in the U.S. is now imported from foreign reserves. No crude oil is produced in Cascade County although refining does take place. Crude oil is the mainstay resource of the transportation industry and is being exhausted rapidly. Exploration for new reserves is continuing.

Natural Gas: Cascade County is considered a potential area for natural gas production. Presently, natural gas is supplied by Canadian and Montana fields in the area. Canadian reserves are now being cut off, thus endangering the heating systems for many residential areas. Depletion of this resource can be expected to cause higher prices for consumers. Increased exploration can also be expected.

Wood: Wood is a renewable resource which can be exhausted when demand is too great. There are some excellent forests in the southern part of Cascade County. Inefficient use of this energy resource is its major problem. Ornamental fireplace systems which lose heating potential are very common. Modification of fireplace design would enhance heating systems in many homes.

Renewable sources of energy available to the United States seem to be in the infancy stage of development. Technology to utilize them has often been available for many years but seldom used. Others are still beyond the technology we have today.

Nuclear Fusion: If scientists could successfully harness the fusion reaction, it would provide a nearly unlimited and virtually pollution-free source of power. However, after twenty (20) years of expensive research, they have yet to do this. Some believe the process will never be perfected.

Geothermal Energy: This energy source is one of the few which is environmentally acceptable and yet has the potential for supplying a significant portion of man's energy requirements. Unfortunately, no major hot spots exist within Cascade County.

Solar Energy: Today there are no technical barriers to the widespread application of solar enrgy to meet U.S. needs. Problems exist in that the cost of converting solar heat to useful forms of energy is now higher than conventional sources. Impact upon the environment with this type of development is generally minimal. Small scale projects on an individual basis for home heating are easily developed and can be applicable within Cascade County. Further information on this subject is included later in this appendix.

Wind Energy: Excellent potential exists within Cascade County for this type of development. Community or individual application is possible in many areas of the county. Development of this type of power source is beyond experimental stages for small scale uses. Little affect upon the environment has been observed and the social impacts are also very low.

Fuel from Waste: Production of synthetic gas called methane from waste is possible through solar-organic processes. Implementation of this system would require major changes in waste collection methods. Potential does exist in Cascade County on smaller scales. Adequate sources of sewage, garbage and organic material would be needed thus eliminating some of the pollution problems we now have.

Tide Energy: Potential for this energy source exists in many coastal areas. Several production centers have been constructed but exact impact upon the environment is not known.

Conservation of energy and development of pollution free households can also help alleviate the energy problem. Household conservation tips are available from many different private and government agencies. They include such things as energy saving architecture designs, solar heaters, wind generators, insulation methods, building materials, etc. Pollution prevention devices such as the Clivus Multrum sewage system are also becoming popular in that they also conserve water. Public awareness of the fact that energy and money can be saved through conservation methods is becoming evident. Consciousness that we are still dependent upon energy sources soon to be depleted must be realized and measures must be taken by the individual to begin the shift to alternative energy sources.

*In an effort to clarify this statement, some social costs may include the destruction or loss of any area as open space, the elemination of scenic views or the loss of one's home and property.

Environmental costs, on the other hand, may include such things as air, water or noise pollution and loss of wildlife habitat, farm or grazing lands.

ENERGY RESOURCE COST CHART

ENERGY RESOURCE	FINANCIAL	ENVIRONMENTAL	SOCIAL	AGRICULTURAL	HEALTH	DANGER
Nuclear Fission	very high	high	moderate	low	very high	very high
Nuclear Fusion	very high	low	low	low	low	moderate
Coal Gasification and Liquification	very high	very high	high	high (if coal is stripped)	low	low
Oil Shale	very high	very high	high	low	high	low
Geothermal	high	low	low	low	low	? (possible quakes)
Solar	high	low	low	low	none	low
Wind	high	low	low	low	none	low
Fuel from Waste	high	none (enhances)	low	none (benefits)	none	low
Petroleum	high	moderate	moderate	low	low	low
Natural Gas	high	moderate	low	low	low	low
Wood	low	high	low	low	none	low
Tide	high	moderate	moderate	none	low	low

SOLAR ENERGY

Solar energy, man's first energy source, was first used for drying agricultural products and the distillation of liquids many centuries before Christ. Little significant interest was shown in solar energy until the 20th century when solar-powered electrical plants were constructed in Egypt in 1913. Interest again lagged until the early 1970's when energy shortages forced research into energy sources which were of constant supply (i.e. such as solar power). Today solar energy is considered to have the highest potential for use in the present and future and is now economically competitive with other energy sources.

Solar heating systems usually consist of flat plate or concentrating collectors which transfer heat to a carrying medium, either liquid or air. The heat is then ready for conversion to usable energy forms for use or storage, in rock or eutectic salts.

Collectors on the earth's surface are subject to interruptions by local weather and the intermittent nature of the solar cycle. These may be balanced by large storage capacity or some supplementary energy sources, such as wind, methane extraction or the more conventional natural gas and electricty. Efficiency of the solar system depends upon a number of local variables including sun angle, days of sunlight, and duration of sunlight.

Cascade County has the potential for supplying much of its individual needs through the use of solar energy systems. The average number of clear or partly cloudy days from sunrise to sunset at the Great Falls Airport is 188. The 177 cloudy days will usually give some benefit from solar radiation, even though the effectiveness of a collector may be reduced. Solar energy systems may be more or less effective, depending on specific site conditions. One of the most important conditions is sun angle, which is discussed later.

Some of the advantages attached to solar energy are:

1) It is a clean, free, inexhaustible source.
2) Solar energy does not add to the thermal burden of the earth.
3) Construction of a solar energy system is relatively quick and easy.
4) It is safe.
5) There is a sufficient quantity.

Disadvantages:

1) The collectors work only when the sun is shining, i.e. the energy is intermittent and of low intensity.

SUN ANGLE

The sun angle is the distance of the sun from above the horizon at a certain latitude on any day. For example, if the sun is directly overhead the sun angle is 90°. The equation for figuring sun angle is:

Sun angle = $90^{\circ} - \phi + \alpha$

ϕ = Latitude

α = Elevation of the sun (degrees latitude the sun is north or south of the equator)

Example for Great Falls, latitude 47.5°N:

summer solstice (longest day of year) $\alpha = +23.5^{\circ}$ (sun's rays are vertical at 23.5°N)

Sun angle = $90^{\circ} - \phi + \alpha$ $\phi = +47.5^{\circ}$ (latitude of Great Falls)

= $90^{\circ} - 47.5^{\circ} + 23.5^{\circ}$

= 66° above horizon

winter solstice (shortest day of year) $\alpha = -23.5^{\circ}$ (sun's rays are vertical at 23.5°S)

Sun angle = $90^{\circ} - \phi + \alpha$ $\phi = +47.5^{\circ}$ (latitude of Great Falls)

= $90^{\circ} - 47.5^{\circ} - 23.5^{\circ}$

= 19° above horizon

autumnal or vernal equinox (fall or spring, when length of day equals the length of night)

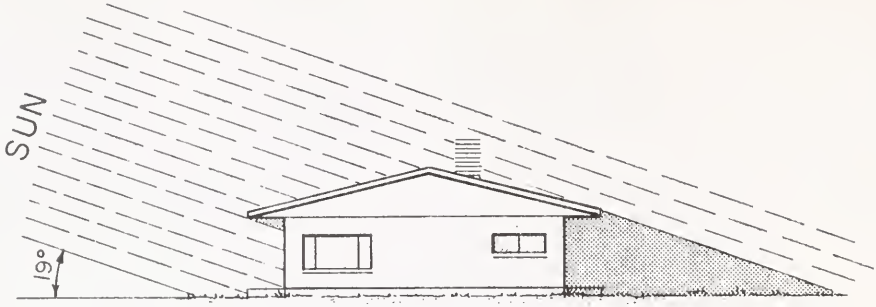
$\alpha = 0^{\circ}$ (sun's rays are vertical at 0° - equator)

Sun angle = $90^{\circ} - \phi + \alpha$ $\phi = 47.5^{\circ}$ (latitude of Great Falls)

= $90^{\circ} - 47.5^{\circ} + 0^{\circ}$

= 42.5° above horizon

Therefore, the sun angle at Great Falls (latitude 47.5°N) varies from 19° on December 22 to 66° on June 22. With this knowledge, it is relatively easy to set up a solar energy system that would make maximum use of the sun's radiation.



WINTER SOLSTICE

DEC. 22

VERNAL & AUTUMNAL EQUINOX

MAR. 23 & SEPT. 22

SUMMER SOLSTICE

JUNE 21

SUN ANGLES at GREAT FALLS, MONT.

LAT. 47.5° N. 12:00 NOON

WIND

Utilizing the power of the atmosphere is not "new"; interest is only reborn. For many, many years wind moved the sailing ships of the world's greatest seapowers. Wind power bore the commerce when this country was young. By 1850 the use of windmills was equivalent to 1.4 billion horsepower hours of work (approximately 1.04 billion Kilowatt hours), but it wasn't until 1894 when the Arctic explorer Narsen used wind to generate electricity.

The Cascade County area has excellent potential for harnessing wind power because of the 13.9 mph average wind velocity found here. Using the December, 1975 National Geographic's example: "Assume that the wind in Chicago blows constantly at (an) average speed of 11.3 miles per hour, but that the average for Minneapolis, also 11.2 mph, comes from winds that blow 8.2 mph for half each day and 14.2 mph for the other half." Because wind power increases as the cube of wind velocity "the city of Minneapolis would have available during its windiest half day as much energy as Chicago would have during the whole day." Average wind speed in Great Falls varies with the seasons.

Advantages of using wind:

1) Wind is everywhere and free.
2) There is no damage to the surrounding environment.
3) It does not add to the thermal burden of the Earth.

Disadvantages:

1) Windmills may be aesthetically displeasing.
2) There are variations in power-plant output because of the fluctuation in duration and intensity of the wind, which necessitates storage facilities.
3) To be usable (in most cases) wind speeds must be greater than 7 mph.

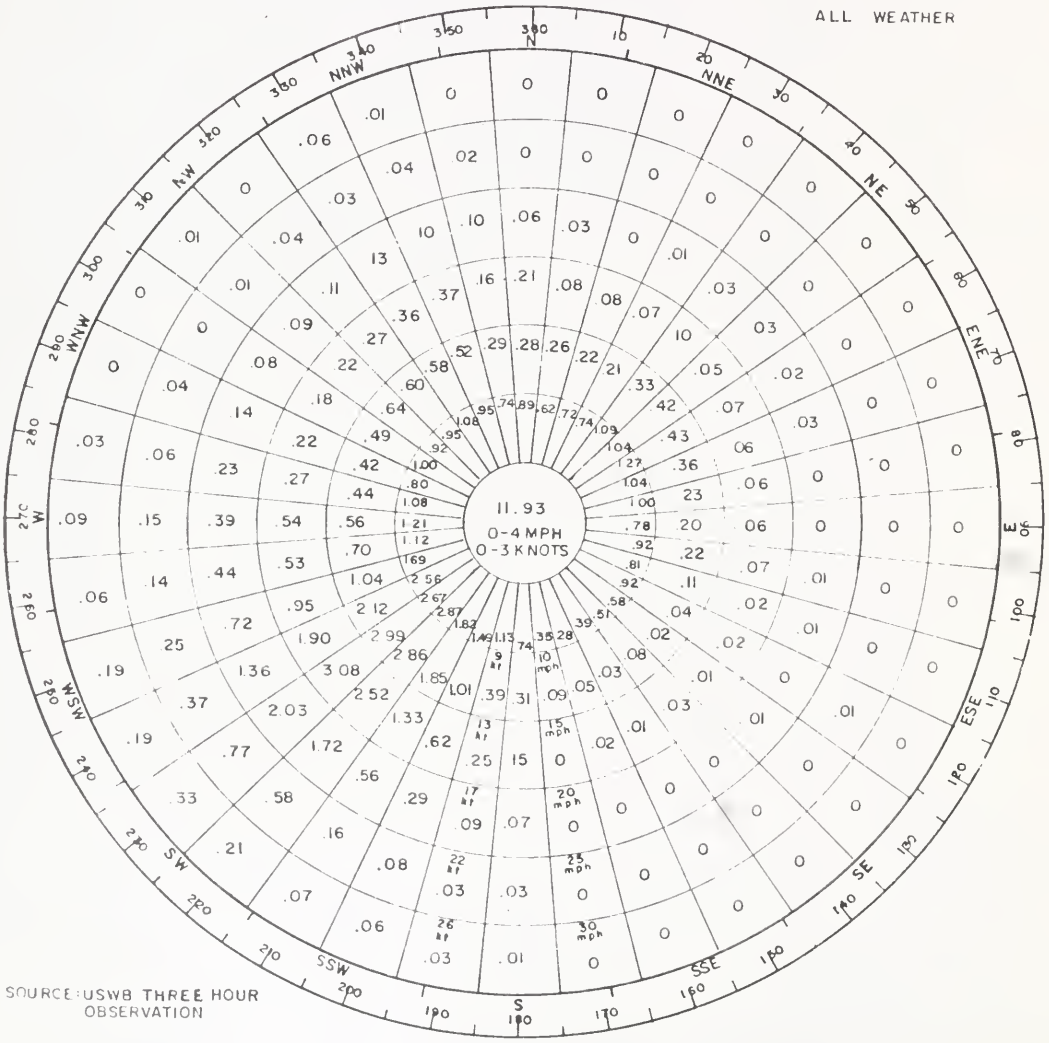
ANNUAL ALL WEATHER WIND ROSE

SHOWING PERCENTAGE DISTRIBUTION

GREAT FALLS INTERNATIONAL AIRPORT
GREAT FALLS, MONTANA

PERIOD: JAN 1, 1964 - DEC 31, 1967
TOTAL OBS ALL WEATHER: 11,688

PERCENTAGES SHOWN ARE OF WIND OBS. DURING ALL WEATHER



SOURCE: USWB THREE HOUR OBSERVATION

Local Climatological Data

Annual Summary With Comparative Data

1975

GREAT FALLS, MONTANA

Narrative Climatological Summary

The city of Great Falls is located astride the main stem of the Missouri River at its confluence with the Sun River, while the Weather Service Office is located at the Municipal Airport on a plateau between the Sun and Missouri Rivers. This plateau is about 200 feet higher than most of the immediate valley area, and the airport is about two miles southwest of the Sun and Missouri River Junction. Except to the north and northeast, the valley is encircled by mountain ranges, which lie about 30 miles away from east to south, 40 miles to the southwest, and 60 to 100 miles distant from west to northwest. Topography plays an important part in Great Falls' climate. The Continental Divide to the west, and Big and Little Belt Ranges to the south, are primary factors in producing the frequent wintertime "chinook" winds observed in this part of Montana. The valley-plateau combination in the immediate area contributes quite often to marked temperature differences between airport and City proper, either on calm, clear mornings, or when "chinook" winds appear at the airport before they are felt at the lower elevations in town.

Summertime in the area generally is quite pleasant, with cool nights, moderately warm and sunny days, and very little weather that can be called hot or humid. Most summer rainfall occurs in showers or thundershowers, but steady rains do occur during late spring and summer. On the average, the maximum temperature reaches 100° or better during four summers out of 10 and an average year will have 20 days with maximums 90° or higher. Freezing temperatures do not occur in July or August, very rarely in June, and are observed only on two or three days in the usual May or September. Frost occurs frequently in April and October, but more often in the valleys than on the surrounding hills or plateau.

Winters are not so cold as is usually expected of a continental location at this latitude, largely as a result of the "chinook" winds for which this area is noted. While sub-zero weather is experienced normally several times during a winter, the coldest weather seldom lasts more than a few days at a time, and is usually terminated by southwest "chinook" winds which can produce sharp temperature rises of 40° or more in 24 hours. As a result of recurring "chinooks" throughout the winter season, snow seldom lies on the ground for more than a few days. In fact, the ground usually is bare, or nearly bare of snow, most of the winter, except in the surrounding mountains and higher foothills. On the other hand, invasions of cold air from the polar regions occur a few times each winter, and sharp temperature falls from above freezing to below zero within 24 hours are observed occasionally from mid-December to March.

Precipitation generally falls as snow during late fall, winter, and early spring, although rain can occur in any month. Late spring, summer and early fall precipitation is almost always rain, but some hail is observed occasionally during summer thundershowers.

Although Great Falls' average annual precipitation would normally classify the area as semi-arid, it is important to note that about 70 percent of the annual total falls normally during the April-September growing season. The combination of ideal temperatures during the peak of the growing season, long hours of summer sunshine, and nearly 10 inches of precipitation during the six critical months, makes the climate very favorable for dryland farming. Heavy fog seldom occurs, incidence usually being limited to about one day per month, but each case lasts only a small part of the day. Although the average windspeed is relatively high, extremely strong winds (over 70 mph) seldom are observed, and visibility normally is excellent (15 miles or more).

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / ENVIRONMENTAL DATA SERVICE / NATIONAL CLIMATIC CENTER ASHEVILLE, N.C.

Meteorological Data For The Current Year

Station: GREAT FALLS, MONTANA — INTERNATIONAL AIRPORT — Standard time used: MOUNTAIN — Latitude: 47 29 N — Longitude: 111 22 W — Elevation (ground): 3662 feet — Year: 1975

Month	Temperature °F: Averages: Daily maximum	Daily minimum	Monthly	Extremes: Highest	Date	Lowest	Date	Degree days Base 65° F: Heating	Cooling	Precipitation in inches: Water equivalent: Total	Greatest in 24 hrs	Date	Snow, ice pellets: Total	Greatest in 24 hrs	Date	Relative humidity, pct: Hour 05 (Local time)	Hour 11 (Local time)	Hour 17 (Local time)	Hour 23	Resultant: Direction	Speed m.p.h.	Fastest mile: Speed m.p.h.	Direction	Date	Percent of possible sunshine	Average sky cover tenths sunrise to sunset	Number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, ice pellets .01 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperature °F: Maximum (b): 90° and above	32° and below	Minimum: 32° and below	0° and below	Average station pressure mb: Elev 3657 feet m.s.l.
JAN	32.4	13.0	22.7	51	23	-16	11	1304	0	1.16	0.49	25-26	13.2	4.9	25-26	71	65	64	70	23	12.7	16.1	45	SW	20	34	7.6	4	7	20	10	5	0	0	0	11	30	6	885.5
FEB	24.1	2.0	13.1	47	28	-24	4	1450	0	0.71	0.21	2-3	7.2	2.1	2-3	78	73	67	76	24	8.3	12.8	34	SW	24	52	6.9	6	6	16	11	3	0	0	0	17	28	14	887.2
MAR	35.1	14.6	27.4	58	18	-2	28	1159	0	1.34	0.55	25-26	12.4	3.5	25-26	80	63	62	77	25	8.0	13.1	58	SW	30	47	8.4	1	9	21	15	4	0	2	0	12	29	1	884.2
APR	39.9	21.9	30.9	60	22	+6	6	1019	0	4.63	1.43	25-26	29.2	8.8	7-8	85	73	65	82	26	5.9	11.9	39	NW	29	39	8.4	2	4	23	18	7	0	8	0	10	22	2	885.9
MAY	60.7	39.2	50.0	82	15	30	26	460	0	3.89	1.28	6-7	5.6	2.5	4-5	77	52	47	70	25	7.0	12.9	36	SW	18	53	7.7	1	10	20	14	3	0	0	0	0	9	0	886.2
JUN	70.7	47.4	58.8	84	24	42	10	190	10	4.47	1.18	18-19	0.0	0.0		73	53	44	68	25	5.1	11.2	31	SW	5	57	7.5	2	10	18	18	0	6	1	0	0	0	0	886.2
JUL	85.7	57.8	71.8	104	27	50	31	42	431	1.20	0.95	30-31	0.0	0.0		72	45	40	60	23	2.6	8.7	42	S	14	74	5.0	11	12	8	9	0	7	0	12	0	0	0	889.3
AUG	77.8	52.0	64.8	95	5	44	24	80	62	2.19	0.83	19-20	0.0	0.0		69	45	37	58	24	5.7	10.6	35	SW	28	77	5.7	9	12	10	11	5	0	0	5	0	0	0	888.9
SEP	72.0	42.8	57.3	86	15	32	30	235	12	0.74	0.39	1	T	T	29	70	44	31	58	25	5.1	10.4	33	W	16	86	3.9	16	8	6	5	0	0	0	0	2	0	0	893.3
OCT	55.4	34.7	45.1	81	3	23	27	592	0	3.49	1.11	13	10.6	6.8	13-14	67	55	53	66	23	9.5	14.2	52	SW	4	54	7.5	3	8	20	10	4	0	4	0	0	12	0	886.2
NOV	42.1	23.6	32.9	76	5	-6	29	981	0	1.01	0.28	28-29	9.7	2.8	28-29	61	53	53	59	23	11.9	15.4	43	SW	3	48	7.0	4	5	18	7	5	0	1	0	9	21	3	887.2
DEC	38.2	18.9	28.6	59	9	-8	14	1122	0	0.55	0.16	30-31	5.7	1.6	30-31	70	63	61	68	23	14.2	17.7	47	SW	4	34	7.9	4	4	23	9	3	0	2	0	10	26	5	887.6
				JUL		FEB						APR			APR									DCT													
YEAR	52.9	31.1	42.0	104	27	-24	4	8560	315	25.24	1.43	25-26	99.6	8.8	7-8	73	57	52	68	24	7.7	12.9	52	SW	4	57	7.0	68	98	203	137	34	21	18	14	89	179	31	887.3

Normals, Means, And Extremes

Month	Temperatures °F: Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal Degree days Base 65° F: Heating	Cooling	Precipitation in inches: Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs	Year	Snow, ice pellets: Maximum monthly	Year	Maximum in 24 hrs	Year	Relative humidity pct: Hour 05 (Local time)	Hour 11 (Local time)	Hour 17 (Local time)	Hour 23 (Local time)	Wind: Mean speed m.p.h.	Prevailing direction	Fastest mile: Speed m.p.h.	Direction	Year	Pct of possible sunshine	Mean sky cover tenths sunrise to sunset	Mean number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, ice pellets .01 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperatures °F: Max: 90° and above	32° and below	Min: 32° and below	0° and below	Average station pressure mb: Elev 3657 feet m.s.l.
tal				15		15					38		38		38		38		38		14	14	14	14	34	25	32	32		33	34	38	38	38	38	38	38	36	14	14	14	14	3
JAN	29.3	11.6	20.5	61	1968	-37	1969	1380	0	0.88	2.05	1969	T	1944	0.74	1966	22.6	1969	9.6	1943	86	82	81	85	15.9	SW	65	SW	1946	49	7.3	*	7	19	9	3	*	1	0	15	27	12	885.4
FEB	35.9	17.2	26.6	64	1968	-24	1975	1075	0	0.74	2.16	1958	0.01	1950	0.88	1951	26.1	1958	11.0	1951	86	59	55	66	14.8	SW	72	W	1954	57	7.3	*	7	17	8	3	*	1	0	8	24	4	887.3
MAR	40.4	20.6	30.5	72	1966	+19	1962	1070	0	0.97	2.18	1967	0.15	1960	1.01	1967	21.3	1967	10.0	1967	85	57	47	82	13.5	SW	73	W	1951	67	7.3	*	9	18	9	3	*	2	0	8	25	3	883.2
APR	54.5	32.3	43.4	83	1969	+6	1975	648	0	1.18	4.63	1975	0.27	1938	2.43	1951	35.4	1967	16.8	1973	88	50	42	81	13.2	SW	70	W	1946	62	7.4	*	8	18	9	2	*	2	0	2	17	*	886.8
MAY	65.0	41.5	53.3	90	1972	19	1967	367	0	2.37	8.13	1953	0.67	1950	3.20	1953	8.1	1955	6.2	1967	89	64	60	86	11.5	S	65	SW	1951	64	6.9	5	10	16	11	3	1	0	0	0	3	1	886.5
JUN	72.1	49.5	60.8	97	1974	32	1969	152	36	3.11	5.39	1965	0.52	1960	2.74	1964	11.1	1950	11.0	1950	90	65	60	86	11.4	S	70	W	1958	65	6.6	6	10	14	12	*	6	1	2	0	*	0	886.2
JUL	83.7	54.9	69.3	105	1973	40	1972	18	151	1.27	4.32	1955	0.04	1959	1.40	1950	T	1966	T	1966	84	37	28	69	10.3	S	73	W	1951	81	4.0	14	12	5	7	0	0	*	0	0	0	0	889.3
AUG	81.8	53.0	67.4	106	1969	37	1965	42	116	.09	4.74	1974	0.03	1969	1.82	1974	0.0		0.0		81	37	29	68	10.5	SW	71	SW	1954	78	4.6	13	10	8	7	0	0	*	0	0	0	0	889.0
SEP	70.0	44.6	57.3	98	1967	23	1965	260	29	1.17	3.58	1941	0.10	1962	1.79	1945	7.7	1954	6.1	1954	86	45	37	57	11.6	SW	73	NW	1945	68	5.6	10	9	11	7	*	2	1	0	0	0	0	891.8
OCT	59.4	37.1	48.3	85	1964	+3	1972	524	7	0.68	3.43	1975	T	1968	1.15	1954	16.8	1975	8.3	1957	82	46	42	58	13.8	SW	73	W	1949	61	4.3	7	9	15	6	1	*	1	0	1	10	*	888.3
NOV	43.4	25.7	34.6	76	1975	-15	1970	912	0	0.81	2.27	1955	0.02	1954	0.97	1946	22.1	1955	10.8	1946	85	56	54	82	15.0	SW	73	SW	1955	46	7.2	5	8	18	7	3	*	1	0	5	21	2	886.4
DEC	34.7	18.2	26.5	61	1962	+43	1968	1194	0	0.71	1.73	1945	T	1954	0.82	1972	25.0	1946	9.8	1945	87	62	61	86	16.1	SW	82	SW	1956	46	7.2	5	8	18	7	3	*	1	0	12	26	7	886.4
				AUG		DEC					MAY		OCT		MAY		APR		APR									DEC												
YR	55.9	33.8	44.9	106	1969	+43	1968	7852	339	14.99	8.13	1953	T	1965	3.20	1953	35.4	1967	16.8	1973	86	50	45	59	13.1	SW	82	SW	1956	64	4.5	82	106	177	100	20	26	13	22	51	156	29	887.2

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 107 in July 1933, lowest temperature -49 in February 1936, maximum precipitation in 24 hours 3.26 in June 1907

a) Length of record, years, through the current year unless otherwise noted, based on January data

(b) 70° and above at Alaskan stations.

* Less than one half.

T Trace.

NORMALS - Based on record for the 1941-1970 period.

DATE OF AN EXTREME - The most recent in cases of multiple occurrence.

PREVAILING WIND DIRECTION - Record through 1963.

WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.

FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees

STATION LOCATION

GREAT FALLS, MONTANA

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude North	Longitude West	Elevation above Sea level: Ground at temperature site	Elevation above Ground: Wind instruments	Elevation above Ground: Extreme thermometers	Elevation above Ground: Psychrometer	Elevation above Ground: Telepsychrometer	Elevation above Ground: Tipping bucket rain gage	Elevation above Ground: Weighing rain gage	Elevation above Ground: 8" rain gage	Elevation above Ground: Hygrothermometer	Elevation above Sea level: Pyranometer	Remarks
COOPERATIVE																
End of Central Avenue Across Park Drive	11/01 91	6/30/98		47° 30'	111° 18'	3331		4					5			
Corner Central Avenue & Second Street	7/01 98	?	500 ft. E	47° 30'	111° 18'	3330		25					18			? - Sometime after 3/22/06, but before 7 15.13.
Post Office Grounds 1st Avenue N & 3rd Street	?	10.16 14	600 ft.NE	47 31'	111° 18'	3328		4					3			
423 Fourth Avenue North	10 17/14	3/31 18	1400 ft.NNE	47 31'	111° 18'	3334		4					3			
1709 Third Avenue North	4 01 18	9/30/19	5500 ft. E	47° 31'	111° 17'	3387		4					3			
412 Thirteenth Street North, Fire Station	10.01/19	3 31/37	2100 ft.WNW	47 31'	111° 18'	3370		4					3			
AIRPORT																
Municipal Airport Gore Field, Wal Hangar 3.1 miles SW of P. O.	11 01 31	12 19 39		47 29'	111 22'	3654	35	4	4				3			SAWRS station to 11 1 36, then CAA.
Municipal Airport Gore Field, Administration Building	12.20.39	8 01 59	No Change	47° 29'	111° 22'	3664	b75	a18	a17		c15	c15	15		c 3697	Weather Bureau from 1 25 40. a - 16 feet 2 22 40 to 11 21 41 b - 63 feet to 6/30/42. c - Added 11/21/41.
International Airport Administration Building	8 01 59	Present	No Change	47 29'	111 22'	c3662	122	18	17		15	15	15	d4	d 3692 g	d - Commissioned 2 4 61 1100 feet W of thermometer site. e - 3664 feet to 2/4/61. f - 23 feet to 11 10 64. g - Decommissioned May 1975.

Requests for additional climatic information should be addressed to: Director, National Climatic Center, Federal Building, Asheville, N. C. 28801

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I certify that this is an official publication of the National Oceanic and Atmospheric Administration, and is compiled from records on file at the National Climatic Center, Asheville, North Carolina 28801.

Thomas D. Potter
Director, National Climatic Center

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210

U.S. MAIL
FIRST CLASS

AMERICA'S REVOLUTION BICENTENNIAL 1776-1976

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1936	19.8	-5.2	34.0	45.0	63.0	66.4	76.4	70.2	58.8	51.3	39.0	25.4	45.3
#1937	3.1	17.8	34.0	46.5	57.4	62.3	72.6	68.0	58.9	52.7	34.0	26.0	44.4
1938	31.0	18.2	34.2	45.8	52.1	61.9	69.3	67.2	65.5	50.2	33.0	29.3	46.5
#1939	32.8	16.7	36.0	48.4	57.7	57.0	72.8	69.6	59.9	47.6	45.2	36.6	48.5
1940	15.8	22.7	36.6	41.1	57.4	64.6	71.3	70.4	62.4	51.6	27.2	32.8	46.2
1941	28.6	28.4	34.6	45.4	55.5	62.4	71.3	67.6	51.8	46.2	39.5	28.5	46.6
1942	27.6	20.0	33.3	47.0	50.4	56.8	69.3	67.2	57.2	50.1	33.3	28.2	45.0
1943	11.7	30.1	24.9	49.6	50.4	58.6	69.4	68.1	59.2	52.1	39.3	32.6	45.4
1944	33.3	24.0	29.2	47.2	57.2	57.6	67.6	64.8	59.4	55.4	33.8	28.6	46.2
1945	28.6	23.6	35.7	36.8	51.1	56.8	71.7	70.2	54.6	51.6	33.4	24.0	45.0
1946	31.6	32.1	41.0	50.0	51.0	61.4	70.6	66.7	57.0	40.5	28.1	26.8	46.4
1947	25.8	23.2	27.5	46.0	55.1	58.3	73.2	66.6	56.6	51.7	30.2	31.0	45.4
1948	29.3	19.9	27.2	43.2	53.0	61.3	66.4	68.6	60.0	50.6	35.6	16.4	44.5
1949	10.0	18.8	31.2	51.0	56.8	61.2	68.8	71.0	58.4	41.5	47.5	19.8	44.7
1950	-3.6	35.3	28.5	40.7	50.8	58.5	66.3	64.5	55.8	49.2	31.7	33.0	42.5
1951	18.2	23.7	19.1	40.8	53.1	54.1	68.2	62.7	52.6	42.0	35.5	15.2	40.5
1952	18.3	27.5	28.0	50.9	54.6	61.2	66.5	66.3	61.3	50.2	33.6	32.5	45.9
1953	32.4	31.2	36.0	38.2	49.1	58.5	70.0	69.1	60.9	54.2	44.6	32.5	48.1
1954	10.2	39.8	25.9	37.0	53.5	56.6	71.5	65.1	55.8	45.8	44.7	34.6	45.0
1955	25.9	21.6	23.0	40.5	49.5	60.4	67.0	70.3	56.0	50.4	19.4	22.3	42.2
1956	20.8	23.5	33.8	41.4	54.3	63.8	69.4	65.1	56.8	47.7	38.3	29.2	45.5
1957	7.9	22.4	33.8	42.8	56.4	61.9	71.8	65.6	59.3	40.7	35.0	36.6	44.5
1958	36.6	23.6	28.1	44.0	61.9	58.9	63.6	71.2	58.5	52.2	33.3	29.9	46.8
1959	23.1	16.9	38.1	43.4	48.5	63.0	70.8	65.8	55.7	44.8	29.7	36.0	44.7
1960	22.8	23.9	31.3	42.8	52.3	62.2	74.5	65.5	60.2	50.2	35.5	30.2	46.0
#1961	32.8	36.0	37.7	40.3	54.8	69.4	70.2	72.4	50.2	46.6	30.0	20.3	46.7
1962	19.0	20.7	25.9	48.1	50.8	61.4	65.0	67.3	56.7	50.5	40.3	32.6	44.8
1963	12.8	36.8	39.4	42.9	52.9	61.4	66.9	68.8	64.0	54.1	38.6	23.5	47.0
1964	28.7	33.0	26.9	42.3	54.6	62.5	72.4	65.4	53.9	53.0	31.9	11.2	44.7
1965	23.9	27.0	20.9	44.7	51.5	60.3	69.6	68.0	45.0	53.4	34.9	29.1	44.0
1966	13.9	27.1	36.4	40.2	55.6	59.9	70.0	65.1	64.2	47.4	29.0	27.9	44.8
1967	26.3	32.1	27.2	35.5	52.5	60.2	73.0	71.0	62.9	50.2	36.2	22.1	45.6
1968	22.0	33.2	40.5	40.6	49.5	59.2	67.6	64.4	56.5	48.0	35.8	16.1	44.5
1969	-2.8	16.6	26.2	50.3	55.8	59.3	66.3	72.1	61.3	38.1	40.1	29.9	42.9
1970	14.7	32.3	29.0	38.5	53.6	66.5	71.4	70.9	54.6	44.7	30.2	23.0	44.1
1971	16.2	29.4	31.6	45.0	54.6	62.0	67.5	76.0	54.7	44.7	36.3	18.0	44.6
1972	12.8	22.5	38.3	42.4	53.5	65.2	64.7	69.6	53.9	43.2	36.3	17.9	43.4
1973	24.9	29.6	39.5	40.2	55.4	63.6	71.4	71.2	58.2	49.2	25.2	28.9	46.4
1974	19.8	33.8	33.3	47.1	49.5	66.9	72.9	62.9	54.6	51.4	38.7	32.5	47.0
1975	22.7	13.1	27.4	30.9	50.0	58.8	71.6	64.8	57.3	45.7	32.9	28.6	42.0
RECORD MEAN	21.2	26.1	31.4	43.3	53.3	60.9	69.7	67.9	57.6	48.3	34.8	27.1	45.1
MAX	30.4	35.9	41.4	54.3	64.9	72.4	83.8	81.8	69.9	59.2	43.8	35.8	56.1
MIN	12.0	16.3	21.3	32.2	41.7	49.3	55.5	53.9	45.2	37.4	25.8	18.4	34.1

Heating Degree Days

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1955-56	88	8	300	444	1364	1318	1363	1198	960	700	341	94	8178
1956-57	40	77	203	532	790	1107	1770	1189	962	661	259	124	7714
1957-58	7	69	197	750	894	877	874	1153	1138	623	144	194	6920
1958-59	106	13	235	400	944	1081	1297	1347	828	637	505	109	7502
1959-60	26	67	310	621	1055	890	1301	1187	1041	660	409	114	7681
#1960-61	11	78	187	455	878	1073	989	807	839	732	326	14	6389
1961-62	4	9	449	566	1043	1378	1426	1236	1208	501	432	140	8392
1962-63	55	57	250	445	734	997	1615	786	788	655	381	144	6907
1963-64	23	23	103	338	782	1279	1118	923	1176	674	318	118	6875
1964-65	0	93	337	375	990	1666	1271	1055	1361	602	411	164	8325
1965-66	17	54	594	355	894	1106	1585	1054	880	736	304	182	7761
1966-67	7	85	101	537	1075	1143	1190	914	1166	878	396	168	7660
1967-68	2	8	136	453	858	1327	1329	914	753	724	472	198	7174
1968-69	38	93	261	520	867	1511	2104	1350	1198	432	292	199	8865
1969-70	27	8	172	828	743	1081	1559	906	1108	785	345	95	7659
1970-71	9	8	319	625	1036	1296	1509	993	1031	594	320	134	7874
1971-72	34	5	326	628	854	1455	1616	1226	820	667	368	77	8076
1972-73	109	23	331	668	856	1458	1240	983	785	739	303	125	7620
1973-74	6	27	226	483	1191	1111	1397	865	974	530	477	85	7372
1974-75	6	109	311	419	783	1000	1304	1450	1159	1015	460	190	8206
1975-76	12	60	235	592	961	1122							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	0	0	0	0	15	34	136	235	67	0	0	0	487
1970	0	0	0	0	4	144	214	197	15	6	0	0	580
1971	0	0	0	0	6	50	120	351	22	8	0	0	557
1972	0	0	0	0	19	87	108	175	5	0	0	0	394
1973	0	0	0	0	14	87	213	226	30	0	0	0	570
1974	0	0	0	0	0	148	253	54	11	7	0	0	473
1975	0	0	0	0	0	10	231	62	12	0	0	0	315

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1936	0.59	1.29	0.43	0.71	1.18	2.12	0.19	0.43	1.17	0.34	0.15	0.56	9.16
#1937	0.55	0.16	0.51	0.22	0.27	3.20	1.43	0.61	1.17	0.33	0.43	0.78	9.66
1938	0.03	0.56	0.46	0.27	3.72	4.52	1.00	1.64	0.75	1.55	0.32	0.02	14.84
#1939	0.29	0.33	0.24	0.88	1.52	2.41	0.66	0.59	1.30	1.21	0.15	0.31	9.89
1940	0.62	0.69	0.83	1.78	2.10	0.91	0.73	0.05	2.24	0.83	1.13	0.18	12.09
1941	0.29	0.36	0.55	1.34	2.07	3.67	2.27	0.68	3.56	0.55	1.11	1.19	17.64
1942	0.46	1.02	0.85	0.35	4.64	2.44	1.50	0.67	1.06	0.56	0.94	0.06	14.55
1943	1.48	0.62	0.51	1.36	1.03	5.32	1.01	0.64	0.61	0.57	0.39	0.42	13.96
1944	T	1.44	1.47	0.75	1.15	3.86	1.24	1.44	1.31	0.04	0.99	0.50	14.21
1945	0.32	0.53	0.76	0.67	1.49	3.24	0.20	0.85	2.60	0.80	0.32	1.73	13.51
1946	0.10	0.12	0.42	0.48	1.70	1.96	1.92	1.18	1.93	1.53	1.78	0.86	13.98
1947	0.50	0.71	1.47	0.40	0.68	3.42	0.26	0.30	2.52	0.54	1.11	0.44	12.35
1948	1.23	0.36	1.42	0.61	3.43	4.84	2.28	0.50	0.72	0.08	0.39	0.53	16.39
1949	1.40	0.79	1.11	0.41	3.21	1.54	0.94	0.27	0.52	0.90	0.05	0.53	11.67
1950	0.91	0.01	2.14	1.47	0.67	2.76	3.54	2.94	0.31	0.03	1.19	0.58	16.55
1951	0.41	1.34	1.22	2.50	2.23	3.57	2.54	2.50	1.44	1.72	0.41	1.71	21.59
1952	0.34	1.63	0.76	0.30	1.57	1.22	0.15	1.21	0.24	0.16	1.36	0.05	9.02
1953	0.55	1.46	0.74	1.85	8.13	5.06	0.06	0.56	1.14	0.09	0.13	0.98	20.75
1954	1.23	0.21	1.01	0.86	1.17	4.71	0.63	2.63	1.86	1.35	0.02	T	15.68
1955	0.80	1.47	1.53	2.48	4.26	1.23	4.32	0.04	0.16	0.54	2.27	0.55	19.65
1956	0.52	0.37	0.38	0.53	1.33	2.58	1.02	1.68	0.44	1.02	0.30	0.59	10.76
1957	1.80	0.73	0.77	0.95	2.82	2.94	0.75	1.11	1.68	1.89	0.61	0.11	16.16
1958	0.56	2.16	1.24	0.67	1.09	4.68	2.32	0.42	0.28	0.31	1.24	1.17	16.14
1959	1.57	1.00	0.58	0.36	2.94	1.88	0.04	0.37	1.55	1.20	1.71	0.43	13.63
1960	0.28	0.52	0.15	2.13	1.71	0.52	0.39	2.66	0.43	0.04	0.79	0.19	9.81
1961	0.22	0.19	0.68	0.96	1.80	0.73	1.01	0.63	1.95	0.32	1.49	0.30	10.48
1962	1.28	0.95	0.74	0.58	5.18	2.30	1.09	1.69	0.10	1.17	0.36	0.51	15.95
1963	1.71	0.32	0.35	1.24	1.27	2.88	0.96	0.49	0.87	0.63	0.21	1.02	11.95
1964	0.65	0.52	1.74	1.91	3.36	4.34	1.50	1.66	0.28	T	0.72	1.23	17.91
1965	0.64	1.18	0.79	2.51	1.47	5.37	1.03	1.58	1.90	T	1.13	0.59	18.39
1966	1.63	0.51	0.79	0.74	1.54	2.17	1.81	0.77	0.21	1.32	1.62	0.99	14.10
1967	1.12	0.28	2.18	3.69	2.17	3.65	0.91	0.23	1.59	1.13	0.26	1.47	18.68
1968	1.29	0.24	0.90	1.11	2.64	2.89	0.06	2.16	2.92	0.11	0.68	1.36	16.36
1969	2.05	0.40	0.44	0.38	1.14	5.33	1.11	0.03	0.13	0.89	0.11	0.40	12.41
1970	0.99	1.02	1.14	1.88	3.16	2.32	1.16	0.77	0.67	1.00	0.53	0.70	15.34
1971	1.22	0.65	1.12	0.66	3.03	0.62	0.27	1.16	0.61	0.30	0.36	1.48	11.46
1972	1.47	0.62	1.01	0.77	1.59	0.94	1.51	1.26	0.85	1.17	0.20	1.68	13.07
1973	0.33	0.26	0.30	2.89	0.95	1.43	0.13	0.85	1.29	0.97	1.36	1.37	12.16
1974	1.44	0.26	1.10	1.03	3.16	1.08	0.48	4.76	0.73	0.36	0.26	0.60	15.26
1975	1.14	0.71	1.34	4.63	3.69	4.47	1.20	2.13	0.74	3.43	1.01	0.55	25.24
RECORD MEAN	0.87	0.70	0.93	1.27	2.40	2.89	1.16	1.19	1.14	0.80	0.76	0.72	14.83

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
#1936-37	0.0	0.0	0.0	1.5	3.0	10.4	14.8	2.5	5.0	2.0	0.0	0.0	39.2
1937-38	0.0	0.0	0.0	T	8.3	9.0	2.0	15.0	9.8	1.0	T	0.0	45.1
1938-39	0.0	0.0	0.0	T	3.4	0.2	3.9	4.5	5.4	1.4	T	0.0	18.8
#1939-40	0.0	0.0	T	T	T	5.6	5.1	7.9	5.8	4.3	T	0.0	28.9
1940-41	0.0	0.0	0.0	T	12.7	2.6	4.7	5.7	4.1	6.6	0.0	0.0	36.4
1941-42	0.0	0.0	7.1	2.5	9.4	15.4	6.7	14.0	8.8	0.3	0.2	0.0	64.4
1942-43	0.0	0.0	T	0.3	13.0	1.1	20.3	8.2	6.9	0.8	3.5	T	54.1
1943-44	0.0	0.0	2.0	2.3	3.5	3.0	T	15.8	16.3	T	T	0.0	42.9
1944-45	0.0	0.0	T	0.0	10.4	7.6	5.7	8.5	5.5	1.1	T	T	38.8
1945-46	0.0	0.0	0.6	4.8	2.0	25.0	1.9	2.2	1.0	T	T	0.0	37.5
1946-47	0.0	0.0	0.0	3.1	17.5	13.2	8.4	10.0	14.7	2.1	0.0	0.0	69.0
1947-48	0.0	0.0	6.4	T	11.1	5.4	12.9	4.3	15.3	5.6	2.4	0.0	63.4
1948-49	0.0	0.0	T	T	3.3	5.8	15.8	10.3	13.8	T	5.4	0.0	54.4
1949-50	0.0	0.0	2.0	7.4	T	7.2	13.2	0.2	20.6	11.1	2.3	11.1	75.1
1950-51	0.0	0.0	2.1	0.3	12.9	7.8	5.0	16.0	14.8	3.5	6.2	T	68.6
1951-52	0.0	0.0	0.6	10.9	4.3	22.9	4.5	19.7	7.4	0.2	0.0	0.0	70.5
1952-53	T	0.0	0.0	T	15.5	0.8	3.6	15.9	7.0	6.8	2.1	0.0	51.7
1953-54	0.0	0.0	0.0	T	T	10.2	15.5	2.0	13.8	10.1	0.8	T	52.4
1954-55	0.0	0.0	7.7	3.1	0.2	T	6.9	18.3	17.1	17.4	4.2	0.0	74.9
1955-56	0.0	0.0	T	2.0	22.1	7.4	6.4	3.0	2.7	4.3	8.1	0.0	56.0
1956-57	0.0	0.0	T	2.4	2.4	10.3	20.7	9.5	6.9	4.0	0.0	0.0	56.2
1957-58	0.0	0.0	3.6	14.2	5.7	0.7	5.3	26.1	15.9	1.2	0.0	0.0	72.7
1958-59	0.0	0.0	T	1.0	13.8	17.6	19.3	14.7	5.0	2.7	T	0.0	74.1
1959-60	0.0	0.0	0.8	8.9	16.6	4.5	3.1	8.1	1.9	16.2	1.7	0.0	59.8
1960-61	0.0	0.0	0.0	T	7.8	2.0	2.9	0.6	7.9	6.1	T	0.0	27.3
1961-62	0.0	0.0	0.4	2.6	15.0	3.0	14.7	8.9	5.9	3.6	T	0.0	54.3
1962-63	0.0	0.0	0.4	T	2.1	3.7	17.7	3.2	3.9	11.1	T	0.0	42.1
1963-64	0.0	0.0	0.0	0.0	2.1	10.6	8.5	5.7	17.4	13.2	T	0.0	57.5
1964-65	0.0	0.0	T	T	7.9	13.8	6.9	12.5	7.7	11.5	T	0.7	61.0
1965-66	0.0	0.0	4.2	0.0	9.7	6.5	16.9	5.8	7.7	6.0	T	0.0	56.8
1966-67	T	0.0	0.0	3.4	15.2	9.6	10.9	2.8	21.3	35.4	8.0	0.0	106.6
1967-68	0.0	0.0	0.0	0.7	2.4	14.9	12.8	1.9	7.6	6.1	T	0.0	46.4
1968-69	0.0	0.0	3.9	0.2	2.6	13.6	22.6	5.2	5.5	0.9	0.1	5.3	59.9
1969-70	0.0	0.0	0.0	5.0	1.1	4.3	9.4	11.4	10.9	18.7	1.4	0.0	62.2
1970-71	0.0	0.0	3.0	6.4	4.9	7.3	16.2	6.9	9.7	4.7	T	0.0	61.1
1971-72	0.0	0.0	T	3.8	4.2	19.2	18.6	6.3	11.4	3.5	0.2	0.0	67.2
1972-73	0.0	0.0	0.5	9.5	2.0	16.2	3.3	1.8	1.8	24.8	0.3	0.0	60.2
1973-74	0.0	0.0	6.0	3.6	12.2	12.8	13.4	2.8	9.5	6.1	T	T	66.4
1974-75	0.0	0.0	1.3	1.1	1.3	5.9	13.2	7.2	12.4	29.2	5.6	0.0	77.2
1975-76	0.0	0.0	T	16.6	9.7	5.7							
RECORD MEAN	T	0.0	1.4	3.1	7.4	8.5	10.0	8.5	9.5	7.4	1.4	0.5	57.7

# Indicates a station move or relocation of instruments. See Station Location table.

Record mean values above are means through the current year for the period beginning in 1938. Data are from Cooperative locations through March 1937 and from Airport locations thereafter.

For more information:

GPO - Catalog on Solar Energy Heating and Cooling Products
(ERDA-75) stock #052-010-00475-1 $3.80

TIC - Solar Energy Program (ERDA-15)
Pamphlet length, general description of ERDA's solar program

GPO - National program for Solar Heating and Cooling
(Residential and Commercial Application) (ERDA-23A)
stock #052-020-00475-1 $2.50

GPO - Definition Report, National Solar Energy Research, Development and Demonstration Program (ERDA-49)
ERDA research plans for photovoltaic, wind, biomass, ocean and solar thermal conversion applications, as well as for heating and cooling
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NTIS - Summary Report, Federal Wind Energy Program (ERDA-84)
overview of research and development activities in wind energy, with abstracts of individual projects. $5.00

GPO - Solar Energy Utilization for Heating and Cooling (NSF 74-41)
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NTIS - Solar Energy: A Bibliography (TID-3351-R1)
Bibliographic citations of scientific and technical information on solar energy in the ERDA energy information data base through 1975
Part I (citations) - $13.75 Part II (index) - $10.75

TIC - Solar Energy Update
A monthly abstract-index journal covering research, development, and demonstration information from ERDA and its contractors with reference to reports from other agencies, institutes, and countries.

- Annual Cycle Energy Systems (ACES)
Pamphlet-length description of one energy conservation demonstration project. Available from: Division of Building and Industries, ERDA, Washington, D.C. 20545

TIC - Solar energy reprints from ERDA
Pocket folder of articles for the layman reprinted from Popular Science, Sunset, etc.

TIC - Solar Energy
Popular-level pamphlet (EDM-527) and more detailed booklet (IB-801) describing solar energy applications

TIC - I've got a question about using solar energy. (EDM-816)
Answers to the questions people ask ERDA about the solar demonstration program and the homeowner's use of solar energy

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Simple, low-cost methods of insulation, using heat, and utilizing the sun.

FEA - Tips for Energy Savers

ECR - The Energy Crisis -- What can we do?
$1.00

SCH - Living with the Energy Crisis
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CP - 350 Ways to Save Energy and Money in Your Home and Car
by Spies, Knozo, Calvin, and Thenis
198 page paperback book $3.95

UNH - How to Set Up a Coal or Wood Stove
a 2 - page brochure

UNH - Home Heating in an Emergency
15 page booklet

UP - Save Your Heating Dollars -- and Keep Your Home Warm
a series of 1 - page brochures

ASE - Spectrum - An Alternative Technology Equipment Directory
$1.00

CM - A waterless, non-chemical method of individual sewage treatment

J - Wood and coal heaters

SAB - Energy Earth and Everyone: A Global Strategy for Spaceship Earth
by Medard Gabel $4.95

For information marked:

OEO - Office of Economic Opportunity
Regional Energy Coordinator
Denver Regional Office - VIII
Federal Building
1961 Stout Street
Denver, Colorado 82002

TIC - ERDA Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

NTIS - National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

GPO - Superintendent of Documents
US Government Printing Office
Washington, D.C. 20402

ASE - Alternative Sources of Energy
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Milaca, Minnesota 56353

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Champaign, Illinois 61820

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University of New Hampshire
Durham, New Hampshire 03824

UP - Cooperative Extension Service
University of Pennsylvania
University Park, Pennsylvania 16802

GLOSSARY

GLOSSARY

ADEL MOUNTAIN VOLCANICS - 3,200 feet of potash-rich volcanic and related intruvise rocks. (Tertiary)

AESTHETIC - Pertaining to a feeling or sense of the beautiful.

ALLUVIAL FAN - A fan- or cone-shaped deposit of alluvium formed where a stream flows out onto a level area or into a slower stream.

ALLUVIUM - Material, including sand, clay, gravel and mud, deposited in river beds, lakes, alluvial fans, valleys and elsewhere by modern streams.

BASALT - A dark colored igneous rock.

BEDROCK - The solid rock beneath the soil and subsoil.

BENCHES - A name applied to ledges of all kinds of rock that are shaped like steps or terraces.

BENTONITE - A clay, formed from the decomposition of volcanic ash, that absorbs water readily.

BITUMINOUS COAL - A mineral that burns with a yellow smoky flame; soft coal.

BLACKLEAF FORMATION - Very black to pink, green and lavender shale and light colored fine-grained quartz sandstone. Much bentonite. (Lower Cretaceous)

BLOWOUT - An area from which soil material has been removed by wind. Such an area appears as a nearly barren, shallow depression with a flat or irregular floor consisting of a resistant layer, an accumulation of pebbles, or wet soil lying just above a water table.

BOOTLEGGER MEMBER (of Blackleaf Formation) - Interbeded gray sandstone, siltstone and shale, and dark gray shale. (Lower Cretaceous)

CARRYING CAPACITY - The capability of a particular environment to support animal life.

CITIZEN'S ADVISORY COMMITTEE (CAC)- A body made up of residents from within a planning district who will make recommendations on planning related matters to the Planning Board.

CLAY - 1. Mineral soil material that is plastic when wet, consisting essentially of hydrated silicates of aluminum. 2. Soil material that contains 40 percent or more of clay, less than 45 percent of sand, and less than 40 percent of silt.

CLAY LOAM - Soil material that contains 27 to 40 percent of clay and 20 to 45 percent of sand.

COLLUVIUM - Mixed deposits of soil material and rock fragments accumulated near the base of steep slopes through soil creep, slides, and local wash.

COLORADO SHALES - Dark gray to gray-black shale. Some siltsone and sandstone and limestone beds locally.

CONGLOMERATE - Rock composed of rounded pebbles cemented together in a matrix of finer material.

CRETACEOUS PERIOD - From 135,000,000 years before present to 70,000,000 years before present.

DEVELOPMENT - Any change in land-use that raises the economic value of a parcel of land.

DIASTROPHISM - All the processes that change the shape of the earth's surface, producing mountains and valleys, continents and ocean basins, etc.

DIKE - 1. A relatively thin, flat surface mass of igneous rock that cuts across the structure of the enclosing rocks or extends through massive rocks. Usually formed by the intrusion of magma into a fissure. 2. An embankment, usually of natural materials.

DISTURBED BELT - The sedimentary layers disturbed during the uplift of the Rocky Mountains.

FAULT - A fracture in soil or in a rock mass along which movement has occurred, causing one side to be displaced in relation to the other.

FERDIG-KEVIN MEMBERS - Gray to dark gray shale, some concretions, numerous bentonite beds. Members of Marias River Shale Formations. (Upper Cretaceous)

FLOOD - A temporary rise in the level of water which results in an inundation of areas not ordinarily covered by water.

100 year flood - A flood of a magnitude such that it has a 1% chance of occurring in any given year.

5 year flood - A flood of a magnitude such that it has a 20% chance of occurring in any given year.

10 year flood - A flood of a magnitude such that it has a 10% chance of occurring in any given year.

20 year flood - A flood of a magnitude such that it has a 5% chance of occurring in any given year.

FLOOD MEMBER - Brown, fine-grained, flaggy to massive, ledge-making sandstone with thin interbeds of dark gray shale. Member of the Blackleaf Formation. (Lower Cretaceous)

FLOODPLAIN - A plain built up by stream deposition which may be submerged periodically by floodwaters.

FLOODWAY - The normal stream channel and that area adjoining the floodplain needed to convey moving waters at flood stage.

FLOODWAY FRINGE - The area of the floodplain lying outside the floodway, but subject to periodic inundation from flooding.

FLOWEREE-CONE MEMBERS - Dark gray and very dark gray shales. (Upper Cretaceous)

FOLD - A bend in rock layers caused by compression of the earth's crust.

FORMATION - A group of strata or layers having certain common characteristics that more or less readily distinguish them from adjacent layers.

GROUNDWATER - All water below the surface. It has its origin in downward seepage of surface water to layer impervious material.

IGNEOUS ROCK - Rock formed by the solidification of magma.

INTEGRITY - An unimpaired condition.

INTRUSION - A body of igneous rock that has penetrated older rock.

INTRUSIVE ROCK - Rocks that have solidified at some distance beneath the surface of the earth.

JURASSIC PERIOD - From 180 million years before present to 135 million years before present.

KOOTENAI FORMATION - Three (3) or more sandstone bodies with interbedded vari-colored claystone and siltstone. (Lower Cretaceous)

LANDSLIDE - The downward movement of large masses of rocks and earth.

LIMESTONE - A sedimentary rock composed mostly of clacium carbonate.

LOAM - The textural class name for soil having a moderate amount of sand, silt, and clay. Loam soils contain 7 to 27 percent of clay, 28 to 50 percent of silt, and less than 52 percent of sand.

LOAMY SANDS - (see sandy loam)

MAGMA - Molten or otherwise fluid rock occurring naturally within the earth. Igneous rocks are believed to have been formed by solidification of magma.

MARIAS RIVER FORMATION - Dark gray shale divided into four (4) members.

METAMORPHIC ROCK - A rock that has been greatly altered from its previous condition through the combined action of heat and pressure. For example, marble is a metamorphic rock produced from limestone, gneiss is produced from granite, and slate is produced from shale.

MISSION CANYON FORMATION - Mostly massive brown to gray limestone. (Upper Kinderhook to Osage)

MORRISON FORMATION - Green, drab, or gray marl containing in lower two-thirds (2/3) numerous lenticular bodies of limestone. Near the base is a persistent sandstone unit. Upper one-third (1/3) contains a preponderance of sandstone beds. (Upper Jurassic)

PERFORMANCE STANDARDS - Regulations involving a specific quantitative measurement of an effect or impact of a particular activity.

PYRITE - Fool's gold. It is an iron and a source of sulfur, but it is not used as an iron source because of the difficulty of extracting the mineral from the ore.

QUATERNARY PERIOD - From about 2 million before present.

REVERSE FAULT - An earth fault in which one block has been pushed up and over the other.

ROCK FALL - The process by which rock becomes detached from a nearly vertical slope resulting in a talus slope.

SAND - Individual rock or mineral fragments in soils having diameter from 0.5 to 2.0 millimeters. Usually sand grains consist mainly of quartz but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more of sand and not more than 10 percent of clay.

SANDSTONE - A porous sedimentary rock consisting of sand held together by such materials as silica or limestone.

SANDY LOAM - Soil of textural class which generally contains 50 percent sand and less than 20 percent clay.

SCARP - An escarpment, which is the steep-faced edge of a cuesta or plateau.

SEDIMENTARY ROCK - A rock composed of particles deposited from suspension in water. Chief groups of sedimentary rocks are conglomerates, from gravels; sandstones, from sand; shales, from clay; and limestones, from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sands have been consolidated into sandstones.

SHALE - A laminated, fine-grained sedimentary rock derived from clay muds.

SILL - An intrusion of igneous rock approximately uniform in thickness, much wider than it is thick, and approximately parallel to the bedding of the sedimentary rock in which it has been emplaced.

SILT - 1. Individual mineral particles of soil that range in diameter between the upper size of clay, 0.002 millimeter and lower size of very fine sand, 0.05 millimeter. Soil of the textural class of silt contains 80 percent or more of silt and less than 12 percent of clay. 2. Sediments deposited from water in which the individual grains are approximately the size of silt, although the term is sometimes applied loosely to sediments containing considerable sand and clay.

SILT LOAM - Soil material having (a) 50 percent or more of silt and 12 to 27 percent or clay or (b) 50 to 80 percent of silt and less than 12 percent of clay.

SILT-SHALES - Shales composed of silt-size particles.

SILTSTONE - A very fine-grained sandstone, the particles of which are predominantly of silt grade.

SILTY CLAY - Soil of this textural class has 40 percent or more clay and 40 percent or more of silt.

SILTY CLAY LOAM - Soil of this textural class has 27 to 40 percent clay and less than 20 percent sand.

SLUMPING - The process by which a more or less continuous mass of earth slips downhill along a curved basal slip plane in such a way that the mass of earth rotates backwards, toward the slope. This is usually a relatively rapid movement.

SOIL CREEP - Slow movement of rock fragments downslope, occurring most commonly when lower soil is nearly saturated with water.

STRATUM (pl. Strata) - A layer of sedimentary rock, or a group of layers consisting throughout of approximately the same material. Stratum, bed, and layer are approximately equivalent terms.

SUBSOIL - A common term that can not be defined accurately. It has been carried over from early days when "soil" was conceived only as the plowed soil and that under it as the "subsoil."

SWIFT FORMATION - Dark gray non-calcareous shale overlain by fine-grained glauconitic sandstone. (Upper Jurassic)

TAFT HILL-VAUGHN MEMBERS - Dull gray, greenish to pinkish bentonitic siltstone. Members of Blackleaf Formation. (Lower Cretaceous)

TALUS - A mass of rock debris that collects at the bottom of a cliff.

TECTONIC PLATE - Any one of the huge movable segments into which the earth's crust is divided.

TELEGRAPH CREEK FORMATION - Yellow (outcrop) to gray-white (subsurface), partly shaly sandstone and sandy shale and gray shale. Usually thin bedded. (Upper Cretaceous)

TERRACE - A relatively flat earth surface, usually long and narrow, bounded by an ascending slope on one side and a descending slope on the other.

TERTIARY PERIOD - From 70 million years before present to 200 thousand years before present.

VIRGELLE SANDSTONE MEMBER - Buff to yellow (outcrop) gray to white (subsurface) fine- to coarse-grained, often salt-and-pepper sandstone. Often forms massive cliffs. Member of Eagle Sandstone. (Upper Cretaceous)

VOLCANICS - Those igneous rocks which have reached or nearly reached the surface before solidifying, the type of which is a lava flow.

WIND EROSION - The removal, transportation, and deposition of rock material by wind.

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This intern report was read and accepted by a staff member at:

Agency: Cascade County Planning Board

Address: County Courthouse
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This report was completed by a WICHE intern. This intern's project was part of the Resources Development Internship Program administered by the Western Interstate Commission for Higher Education (WICHE).

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